Escola Nacional de Saúde Pública

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# Successful weight loss maintenance: a systematic review of weight control registries

XX Curso de Mestrado em Saúde Pública

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# Successful weight loss maintenance: a systematic review of weight control registries

Dissertação apresentada para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Saúde Pública, realizada sob a orientação científica de Professor Doutor Carlos Matias Dias e Professora Doutora Inês Santos.

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## ABSTRACT

**Background:** Weight loss maintenance is challenging, but crucial to obtain long-term health benefits. Weight control registries identify psychological and behavioral characteristics of successful weight loss maintainers, potentially improving our understanding of this process.

**Objectives:** To characterize the existing weight control registries and their participants, and identify correlates of weight loss maintenance.

**Methods:** A comprehensive search of peer-reviewed articles published until November 2018 was conducted in 3 electronic databases: PubMed, Web of Science and Scopus. To be selected, studies needed to include samples from weight control registries.

**Results:** 49 articles, corresponding to five weight control registries (United States, Portugal, Germany, Finland, and Greece), were included. Registries slightly differed on the inclusion criteria and procedures. Of 51 identified strategies, grouped in 14 domains of the Oxford Food and Activity Behaviors Taxonomy, having healthy foods available at home, regular breakfast intake, increasing vegetables' and decreasing sugary and fatty foods' consumption, and reducing fat in meals were the most frequently reported for weight loss and maintenance. Physical activity was the most consistent positive correlate of the magnitude of weight loss maintenance.

**Conclusions:** To the extent of my knowledge, this is the first systematic review compiling information on weight control registries. Key characteristics were identified, which can be considered for future weight management initiatives.



**Keywords:** weight loss maintenance, behaviors, correlates

## RESUMO

**Introdução:** A manutenção do peso perdido a longo prazo é um processo desafiante, contudo é essencial para sustentar os benefícios para a saúde decorrentes da perda de peso. Os registos nacionais de controlo do peso permitem alargar o conhecimento nesta área, ao identificarem as características comportamentais e psicológicas de indivíduos que tiveram sucesso na manutenção do peso perdido.

**Objetivos:** Identificar e caracterizar os registos nacionais de controlo do peso e os seus participantes, bem como identificar correlatos da manutenção do peso perdido.

**Métodos:** Realizou-se uma pesquisa sistemática de artigos revistos por pares publicados até novembro de 2018 em três bases de dados eletrónicas: PubMed, Web of Science e Scopus. Foram selecionados para entrar nesta revisão os estudos que incluíam amostras de registos nacionais de controlo do peso.

**Resultados:** Foram incluídos 49 artigos, que correspondiam a cinco registos nacionais de controlo do peso (Estados Unidos da América, Portugal, Alemanha, Finlândia e Grécia). Foram reportadas 51 estratégias e posteriormente agrupadas em 14 domínios segundo a *Oxford Food and Activity Behaviors Taxonomy*. As estratégias mais reportadas foram: ter alimentos saudáveis em casa, tomar regularmente o pequeno-almoço, aumentar o consumo de vegetais, e reduzir o consumo de alimentos com elevado teor de gordura e açúcar. A prática de atividade física destacou-se como sendo o correlato positivo mais consistente com a manutenção do peso perdido.

**Conclusões:** À extensão do meu conhecimento, esta é a primeira revisão sistemática a compilar informação relativa aos registos nacionais de controlo do peso. Foram identificadas características-chave, as quais poderão ser consideradas em iniciativas futuras de saúde pública no âmbito da gestão de peso.



**Palavras-chave:** manutenção do peso perdido; estratégias; correlatos

# TABLE OF CONTENTS

# LIST OF TABLES



# LIST OF FIGURES

# LIST OF ABBREVIATIONS

| | |
|---|---|
| **BMI** | Body Mass Index |
| **WHO** | World Health Organization |
| **DALY** | Disability-Adjusted Life Years |
| **AMA** | American Medical Association |
| **OxFAB** | Oxford Food and Activity Behaviors |
| **US** | United States of America |

# Introduction

Obesity is a growing public health threat.[1,2] According to the World Health Organization, in 2016, more than 1.9 billion adults were overweight; of these over 650 million were obese and the numbers have been increasing over the years.[3] Recently considered as a chronic, relapsing, progressive disease that requires intervention (both prevention and treatment),[4] and considering all the derived health consequences[5,6] and the economic costs associated with it,[7] it is imperative to take action.

In fact, a recent systematic review, including 1.184.942 individuals, showed that 42% of adults worldwide try to lose weight annualy.[8] Weight loss is relatively attainable, however, preventing weight regain after weight loss remains the biggest challenge in obesity treatment. Behavioral interventions addressing diet and physical activity are moderately effective in slowing regain of weight after initial weight loss only up to 2 years,[9] and most individuals experience significant weight regain in the long-term.[10-12] However, successful weight loss maintenance is critical to uphold health benefits.[13] Therefore, a deeper understanding of the successes and failures is needed, in order to provide (the high number of) individuals actively trying to lose weight[8] with more effective solutions/strategies proven for life-long weight management.

The National Weight Control Registry, implemented in the United States of America, pioneered the study of successful weight loss maintenance, detailing the most influential psychological and behavioral characteristics of individuals who achieved success.[14,15] Following this initiative, several countries implemented registries on a voluntary basis, with the same goal of studying successful maintenance of weight loss in their own populations.[(e.g.,16-19)] Yet, each registry has its own specificities.

The process of weight loss maintenance involves complex interactions between behavioral, physiological, environmental and cognitive/psychosocial determinants.[20,21] The most recent systematic review on the determinants of weight loss maintenance showed that weight loss maintenance relies on energy intake-reducing behaviors and energy expenditure-increasing behaviors, and not on the individual's demographic background.[22] Additionally, the determinants promoting these behaviors – for instance, self-efficacy for weight management (i.e., monitoring weight and eating behavior),[22,23] autonomous motivation and a positive body image[24] - also play an important role. Still, evidence in regard to psychological, social, physical and macro-environmental determinants remain scarce and ambiguous.[22]

Expanding the knowledge on the lifestyle patterns of individuals who succeeded in weight loss maintenance and on the social, psychological and behavioral characteristics that most contribute to their long-term success may provide useful insights for future public health and obesity prevention and treatment initiatives.

### *Research questions*

Considering losing weight and maintaining it the key path to possibly reverse the obesity trends and, consequently, promote public health, it is important to understand the universe of people who succeed in long-term weight loss maintenance. *Who are these individuals and how are they studied? Which cognitive and behavioral strategies have they used in order to successfully lose and maintain weight loss? Which factors can potentially explain their success?*

### *Objectives of the study*

The present dissertation sought to provide answers to the previous questions and therefore was primarily designed to:

i) systematically identify and describe the existing weight control registries across the world;

ii) provide a comprehensive description of the sociodemographic, cognitive and behavioral characteristics of their participants (i.e., individuals who successfully achieved long-term weight loss maintenance);

iii) synthesize the sociodemographic, behavioral and psychological correlates of weight loss maintenance magnitude.

### *Outline of the dissertation*

This dissertation contains several novel attributes aiming to contribute to the body of literature in the field of health, obesity and weight management, and it is organized, as follows:

- A general *Introduction* aiming at presenting an overview of the topic that informs the main research questions and objectives of the present dissertation;
- A review of the pertinent evidence (*Literature Review*) on the obesity problem and weight loss and maintenance-related processes, as well as on the public health initiatives for counteracting overweight and obesity;

- A comprehensive description of the methodologic aspects of this dissertation (*Methods*);
- A general description of the main *Results*, which is presented in both tabular and textual form, as well as an integrated *Discussion*. Future implications and recommendations derived from these results are drawn and discussed.
- Finally, the *Appendices* section includes:
    i) The protocol of the study;
    ii) The tool used to assess the methodological quality of the studies included in the systematic review;
    iii) The abstracts of poster communications related to this dissertation.

*Part of the present dissertation was submitted as a systematic review article in a peer-review journal in the field of obesity with an established ISI Impact Factor of 8.192. This article was revised by the Principal Investigators of the weight control registries – Inês Santos (Portugal), James O. Hill (United States), Martina de Zwaan (Germany), Mary Yannakoulia (Greece) and Sirpa Soini (Finland) as well as by Carlos Matias Dias, Eliana Carraça, Pedro J. Teixeira and Rui Jorge.*

# Literature review

## *Overweight and obesity: underlying causes and consequences*

Overweight and obesity are defined as "abnormal or excessive fat accumulation that may impair health" and are commonly classified using the Body Mass Index (BMI) (weight in kilograms divided by the square of the height in meters).[3] BMI has some limitations, as it does not account for the weight associated with lean or fat mass.[25,26] Therefore, is an indicator with high specificity but low sensitivity as it may not identify all the individuals with a high percentage of body fat,[27] probably resulting in underestimates of excess adiposity prevalence.[26] Despite its limitations, it is considered a universal indicator to classify individuals' nutritional status[3] and it is vastly used in research.[(e.g.,1,28)] The World Health Organization (WHO) classifies overweight as individuals having a BMI $\geq$ 25 kg/m$^2$ and obesity as individuals having a BMI $\geq$ 30 kg/m$^2$.[3]

Excess weight results of a sustained energy imbalance over time,[29] which depends on two axes: physical activity and energy intake.[30] When energy intake exceeds energy expenditure,[30] it leads to an accumulation of fat in fat cells. The widening and/or increase in number of fat cells, increase the production of cytokines and other proinflammatory peptides released by them[31] and might provoke metabolic consequences, such as insulin resistance, increased vascular volume, greater arterial resistance, release of angiotensinogen and increases on turnover of cholesterol, leading to several health conditions.[4] In fact, in 2015, overweight contributed to 4.0 million deaths and 120 million disability-adjusted life years (DALYs) worldwide[5] (i.e., the sum of the years of life lost due to premature mortality in the population and the years lost due to disability for people living with the health condition or its consequences).[32] Excess weight is, therefore, a major risk factor for morbidity and mortality since it is closely linked to non-communicable diseases such as diabetes mellitus, cardiovascular disease,[34] cancer,[33,34] musculoskeletal disorders[35] and also to psychological impairments, such as depression[36] and anxiety.[37]

Besides the health consequences, excess weight also imposes an economic burden since a higher BMI is associated with a decrease on productivity at work, lost workdays, permanent disability, early mortality and increase of healthcare

consumption.[7,38] The global economic burden of obesity is, therefore, estimated to be $2.0 trillion (equivalent to that of smoking and armed violence/war/terrorism).[39]

According to the WHO, in 2016, 39% of adults (≥18 years old) were overweight and 13% were obese.[3] In Portugal, the latest National Food, Nutrition and Physical Activity Survey showed that 36.5% of adults (18-64 years old) were pre-obese (BMI 25kg/m$^2$-30kg/m$^2$) and 21.6% were obese.[40] Since 1975, the worldwide prevalence of obesity nearly tripled[3] and evidence forecasts even more dramatic increases by 2030.[41,42]

The etiology of overweight is multifactorial since complex interactions between behavioral, physiological, environmental and social factors are involved.[43] Maintaining a healthy diet and being physically active (two critical behaviors in order to keep a healthy weight) has become a more and more difficult task, as profound changes in our social and economic environments occurred over time. For example, the improvement of food distribution systems, providing an increasing supply of abundant, inexpensive, energy-dense and often nutrient-poor food, as well as the growth in industrialization, urbanization and mechanization.[44] Swinburn *et al.*[44] proposed a framework to categorize obesity determinants, giving special importance to these environmental and social drivers, such as cultural body-size preferences, the food supply and marketing environments which promote high energy intake. Another environmental factor is the built environment. The urban design and the urban physical environment (for instance the security of streets, existence of green spaces and infrastructure supporting active transportation)[45,46] can facilitate or constrain physical activity and, consequently, can have an impact on BMI.[47] Genetic factors are also suggested to play a role on susceptibility to obesity by, for instance, affecting the function of appetite control centers in the brain due to defects of leptin (the hormone responsible for the satiety)[48] or a defective leptin receptor and therefore influencing human eating behavior.[49] However, the significance of genes on obesity remains somewhat inconclusive, as these mechanisms need time to be studied in detail.[50,51] Although influenced by all these factors, the final decision of choosing one or other behavior is undoubtedly individual.[44] For this reason, individuals with excess weight are often stigmatized and accountable for their condition as a result of their lifestyle choices that can be seen as a reflection of ignorance or limited motivation.[52,53]

Universally regarding obesity as a disease would possibly change this perception[52] and could help on obesity intervention,[4,53] by two means: i) the legal and political effects related to prevention and treatment of obesity and 2) the psychological

and social effects concerning stigmatization and self-image.[54] Portugal was one of the first countries to recognize obesity as a chronic disease in 2004,[53] however not many countries adhered to this. In 2013, the American Medical Association (AMA) recognized obesity as a disease[55] and, as being the most influential medical association in the United States of America, it was expected their statement to have an impact on health care policies.[56] In fact, after that statement, some changes on obesity care coverage were verified. For instance, in 2015, the National Conference of Insurance Legislators stated that legislatures should provide for "coverage of the full range of obesity treatment".[52] AMA decision had, nevertheless, some controversy. Obesity, being regarded as a disease, can reinforce treatment efforts via surgery or medications rather than preventive ones through lifestyle behavior changes.[56] In fact, in what it comes to prevention, it seems to have been a "patchy progress" with some "isolated areas of improvement".[57] Experimental data also suggested that viewing obesity as a disease could possibly have a negative effect on self-regulation of dietary behavior (i.e., on a disease-message, individuals gave less importance to their lifestyle choices and were also more satisfied with their body, leading to poorer healthier choices).[58]

More recently, the World Obesity Federation, in a position paper published in 2017, defined obesity as a chronic, relapsing, progressive disease that requires intervention.[4] From their point of view, obesity can be regarded as a disease being caused by a primary agent (energy density food) and followed by other agents such as low physical activity (depending this on the susceptibility of the host). An analogy between the efforts that have been made to control infectious diseases (e.g., improved sanitation) and the efforts needed to control this obesity epidemic was set, proposing that the "agents" must be reduced. Such efforts would ideally include inter-governmental collaborations, health care professionals and health services, environmental authorities, food industry, and others.[4]

### *Obesity prevention: the first step to deal with this public health concern*

One of the Sustainable Development Goals stated by the United Nations is to "ensure healthy lives and promote well-being for all at all ages" and one of its targets is "by 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment (…)".[59] Therefore, effective actions on the underlying causes of these diseases, including excess weight, are imperative.

The prevention of obesity is considered a key area to reduce its prevalence, considered so, or even more, important than treatment.[60] Prevention actions can be translated into health promotion policies, programs, legislative measures, and other initiatives.[61] These should consider not only the obesity itself but also its determinants.[62] Taking this into account, a proposed framework suggests that public health practices in this area should i) target the food, physical activity and socioeconomic environments (for example, through fiscal food policies, restrictions on marketing of unhealthy foods, implementation of urban planning policies); ii) influence eating and physical activity behaviors (acting, on individual settings like workplace, schools, home, promoting healthy environments) and iii) support health services and clinical interventions (for instance, increasing the number of health professionals and providing professional/organizational support and training).[63]

This multilevel approach for tackling obesity is supported by several entities,[64,65] suggesting that obesity prevention demands the collaborative engagement of multiple sectors both in health and non-health sectors (trade, agriculture, transport, economic, education, etc.), therefore, defending the concept of "health-in-all policies" (i.e., accordingly to WHO, an "approach to public policies across sectors that systematically takes into account the health implications of decisions, seeks synergies, and avoids harmful health impacts in order to improve population health and health equity").[66] Building policies and programs based on evidence[67] and evaluate the cost-effectiveness of policies and programs is also necessary to support decisions and to produce results with the minimum costs.[68] Another crucial phase of obesity prevention is the monitoring and evaluation that should be enhanced in order to facilitate posterior dissemination.[67]

When designing and implementing prevention policies, health inequities should be considered. Low socioeconomic groups seem to be more vulnerable to excess weight,[69] probably because they have less access to health care services, lower income, and disadvantaged living conditions.[69] Therefore, policies should not sharpen inequities and, for the best, should reduce them. WHO recommends the following key policies for this specific group: offering comprehensive health through primary care, maternal/child health services and turning healthy foods to be affordable, accessible and available.[69]

In fact, in order to encourage the consumption of healthy foods instead of unhealthy foods, the application of taxes and subsidies has been suggested. This results, in practice, in reductions on the price of healthy foods, such as fruits and vegetables, and increases in the price of foods that are shown to be associated with higher energy intake and body weight,[70,71] such as fast food or sugar-sweetened beverages. Indeed, evidence shows that changes in prices of specific foods can change

dietary patterns[72] and, consequently, can have an impact on weight outcomes.[73] Facing the evidence on the potential harmful effect of consuming sugar-sweetened beverages, Portugal implemented taxes on this type of products in 2016. Data from the *Associação Portuguesa das Bebidas Refrescantes Não-Alcoólicas* showed a decrease in 4.9% of the total sales between 2016 and 2017. This measure had effects on the sugar content of the drinks as well, resulting in a reduction of 11.2% on the energetic value of the sugar-sweetened beverages. These changes have resulted in a decrease of 15.2% of the total sugar commercialized in form of these drinks.[74]

Although deaths from non-communicable diseases occur in adults, the exposure to risk factors begin in childhood. Therefore, several policies and programs to promote healthy habits since early age are encouraged.[61] Marketing can influence consuming patterns, especially in children and adolescents.[75,76] One study that analyzed the cost-effectiveness of obesity prevention interventions in Australia concluded that the reduction of television advertising of high fat and/or high sugar foods and drinks targeting children is one of the best cost-effective interventions.[77] In Portugal, a legislative measure (Lei n.º 30/2019) was recently approved by the Parliament with the main goal of limiting the advertisement of food and drinks high in energy, sodium, sugar and saturated/trans fatty acids in schools, parks and in media channels (30 minutes before and after children's and adolescents programs). Since health literacy seems to be associated with lower BMI (particularly in children),[78] promoting healthy lifestyles through increasing of healthy literacy and empowering of individuals could also be an effective way of addressing obesity. In fact, the Shanghai Declaration on Health Promotion recognizes health literacy as a critical determinant of health and a way of empowering individuals having control of their lives.[79]

The WHO published an Action Plan – "European Food and Nutrition Action Plan 2015-2020", which intends to reduce the burden of preventable diet-related noncommunicable diseases, obesity and other forms of malnutrition. One of the objectives of this Action Plan is to support surveillance, monitoring, evaluation and research.[80] This goal is also stated on the "Vienna Declaration on Nutrition and Noncommunicable Diseases in the Context of Health 2020".[81] These systems of surveillance and monitoring are particularly implemented to prevent childhood obesity (e.g., Childhood Obesity Surveillance Initiative, an European project, which intends to measure trends in overweight and obesity among primary school aged children through taking standardized weight and height measurements, providing nationally representative data and comparisons between countries).[82] In the United States, studies like the Behavioral Risk Factors Surveillance System, the National Health and Nutrition

Examination Survey and the National Health Interview Survey intend to monitor the health of north-American people by collecting and analyzing data on a broad range of health topics (covering diseases, medical conditions, health indicators).[83] In Portugal, studies like the National Health Survey and the National Food, Nutrition and Physical Activity Survey[84] provide similar data for the Portuguese population.

### *Obesity treatment: achieving weight loss and maintenance*

The high prevalence of overweight and obesity indicates that there are many individuals already requiring treatment. And actually, there seems to be an active investment of a big proportion of the population in trying to change their lifestyle, as 42% of the worldwide population try to lose weight every year and 23% try to maintain it.[8]

Success in weight loss is defined by losing 5-10% of the initial weight within 6 months.[13] There is currently no consensus regarding success on weight loss maintenance.[85] Some authors consider weight loss maintenance as achieving an intentional weight loss of at least 10% of initial body weight and maintaining this body weight for at least one year,[86] others consider long-term weight loss maintenance as a weight change <3% of the new body weight,[85] whereas others consider a weight change of ± 5lb (2.3 kg).[87]

Success in weight loss is relatively attainable. Lifestyle interventions, for instance results of the Look AHEAD study (the largest and longest randomized trial of an intensive lifestyle intervention on weight reduction), show that participants on the intervention group achieved an average weight loss of 8.6% and a 21% improvement in cardiovascular fitness at 1 year.[88] In fact, a weight loss of at least 3% to 5% is already associated with better clinical outcomes (e.g., improvement on blood parameters such as reductions in triglycerides, blood glucose, and reduction in the risk of developing type 2 diabetes). A larger weight loss adds other benefits (e.g., reduction in blood pressure and low-density lipoprotein cholesterol and increases in high-density lipoprotein cholesterol).[13] However, this weight change must be maintained over time to sustain the health benefits[13] and the great majority of individuals who lose weight cannot sustain the weight lost in the long term.[10-12] Results of the Look AHEAD study show, in fact, some weight regain, having participants an average weight loss of 4.4% at 4 years and 4.7% at 8 years.[89] This leads to repeated weight control attempts, which in turn is a predictor

of unsuccessful long-term weight loss,[90] putting the individual stuck in a cycle of weight loss and regain.

*So, what can be done to improve the rates of success in the maintenance of weight loss?*

The process of weight loss is likely to include some diet induced energy restriction. Evidence reports that the physiological mechanisms underlying weight regain after weight loss are related with several compensatory adaptations to diet-induced energy-restricted weight loss, which leads to a reduction in energy expenditure and changes in the hormone pathways.[91,92] More specifically, decreases in fat oxidation and anorexigenic hormone (e.g., leptin) levels and increases in appetite, craving and orexigenic hormone (e.g., ghrelin) levels.[92] The role of gut microbiome is yet to be deeply explored but some studies suggest that it can also pose an association with it.[93] Although the physiological adaptations can be crucial for successful weight loss and maintenance, they can be strengthened or countered by other factors.[94] A recent systematic review showed that demographic factors (more specifically, age, gender and socioeconomic status) were not predictors of weight loss maintenance, however, cognitive and behavioral determinants seemed to be predictive determinants.[22] In fact, one behavioral strategy to compensate the physiological adaptations derived from diet-induced energy restriction is physical activity, which can mitigate the effects of reduced energy expenditure.[95]

A meta-analysis of randomized controlled trials comparing diet and physical activity interventions *versus* diet alone concluded that the combination of diet and exercise could help individuals to lose the greatest amount of weight.[11] A more recent meta-analysis found that physical activity could not make any significant difference on the amount of initial weight loss but can help maintaining it over 12 months.[96] In fact, the evidence supports that dietary intake and physical activity should be addressed simultaneously in order to produce sustainable positive changes in weight.[9,97] All these aforementioned findings are in-line with the most recent guidelines for the management of overweight and obesity in adults, which recommends behavioral interventions targeting the consumption of a reduced-calorie diet and high levels of physical activity for its association with sustainment of weight loss over time.[13,21,98]

Physical activity is undoubtably a key behavior to weight management,[99,100] and its benefits for health are well known.[101] The American College of Sports Medicine states that physical activity of moderate intensity for 250 to 300 minutes per week with an

energy equivalent of 2000 kcal per week is recommended to prevent weight regain (and that can be translated into ~60 minutes walking per day at a moderate level).[100] However, individuals who want to lose more than 5% of body weight or are trying to keep a significant amount of weight loss off may need to do more than 300 minutes per week of moderate-intensity physical activity.[102] Aerobic activity (such as brisk walking, running, swimming, bicycling) appears to be more effective on preventing weight gain than muscle-strengthening[102] (although this type of physical activity helps on maintenance of lean mass, which has demonstrated to be essential for health).[103] Besides individual variability which is a matter of concern,[104] the risk for weight regain may vary over time and, consequently, the need for physical activity may vary as well.[100]

The other axis of the energy balance equation, the caloric-reduced diet, should take into account the health status and preferences of the individuals.[13] It should be safe, effective, nutritionally adequate, economically affordable and, preferentially, sustainable over time.[105] Although studies on dietary strategies for weight loss are numerous, the same pattern is not found for weight loss maintenance, where randomized controlled trials testing different dietary approaches are lacking.[106] A recent systematic review on the determinants of weight loss maintenance found that only high levels of energy and fat intake are associated with poorer weight loss maintenance,[22] with other macronutrients not showing a significant impact on determining weight loss maintenance. Supporting this, weight management guidelines show no big difference between dietary approaches with different macronutrient compositions, as long as they promote energy deficit.[13] In fact, the level of adherence appears to play a more important role as it is a stronger predictor of weight loss outcomes than the type of diet itself.[107]

This energy intake relies directly on eating behavior. Therefore, cognitive determinants related to eating behavior seem to have a relationship with maintenance of weight loss.[22] These eating behaviors can be classified in cognitive restraint (the ability of an individual to consciously limit food intake to control body weight), general disinhibition (the inability to restrict eating in certain circumstances such as anxiety, social situations, etc., despite not being hungry), which can be splitted into two distinct concepts – internal disinhibition (eating in response to cognitive/emotional cues) and external disinhibition (eating in response to environmental cues); and hunger (the tendency to eat in response to perceived physiological signal).[108] Several studies have found that having high levels of disinhibition (and, more specifically, internal disinhibition) is negatively associated with successful weight loss maintenance.[22,109] Eating in

response to emotions can increase the amount of energy eaten,[110,111] possibly promoting an energy imbalance.

Sustaining weight loss over time implies keeping healthy lifestyles throughout time and to resist to all the factors that led individuals to excess weight, which unveils difficult to many people.[112] To achieve successful weight management, it is important to consider the readiness and commitment of the individual[13] for long-term adherence to behavior changes.[20] Therefore, it is also proposed the use of behavior change techniques to ease the adherence to the recommendations, including self-monitoring.[13] Self-monitoring is a self-regulation strategy which implies recording specific behaviors or outcomes on a regular basis and can be translated into practice, for example, in recording dietary intake/physical activity or self-weighing.[113] A growing body of evidence within this area shows that the use of mobile health technologies besides allowing self-monitoring, also provides immediate and tailored feedback to the individual.[114] Yet, as this is a recent topic on weight management, more research is needed. Self-monitoring techniques seem to help individuals on maintaining weight loss[22,115] by providing self-evaluation of progress towards individuals' goal increasing awareness[116] and a feeling of control over one's life.[117] In fact, two randomized trials found daily self-weighing to be associated with weight loss maintenance.[118,119] Some authors have pointed out some possible adverse psychological effects such as worsen of body image or mood status by frequently enhance that the individuals' body size is not suitable.[120] However, this association is not consistent between studies and the benefits derived from self-weighing seem to outweigh the possible negative effects.[121,122]

This strategy seems to interact with goal-setting, which implies the setting of specific behavioral or outcome targets.[113] These two strategies predict better results at both short and long term of behavior change interventions,[123] and seem to act synergistically, given that when individuals monitor their progression towards their goal, they can adjust their behavioral efforts (if/when needed) and more easily attain their goals.[124] However, the setting of these goals should be realistic and reasonable.[13,125] Several studies report that having excessively higher weight loss expectations rather than realistic ones are positively associated with drop-out rates in the process of weight management.[90] Since this process is not linear, keeping excessively high expectations and not corresponding to them can be frustrating to individuals and, if their desired weight seems to be unattainable, they consider that the efforts are no worthwhile and, consequently, they might give up their weight control attempts.[126,127] Although 5-10% weight loss within 6 months is the recommended goal to obtain the best results,[13] the

majority of individuals found a weight loss of 5-10% disappointing and therefore report unrealistic weight goals (this seems to be particularly true for individuals with higher BMI).[128]

These previously mentioned strategies seem to increase self-efficacy, i.e., individual's confidence in their abilities to make the behavior changes necessary to achieve their goals and to face a variety of obstacles.[129] Having high levels of self-efficacy seems to affect weight outcomes by affecting weight control behaviors,[129,130] and it was also found to be positively associated with weight loss maintenance.[22,24,131]

In behavioral interventions, weight losses usually have the standard deviation as large as the mean, and this variability is even more evident during maintenance.[20] Understanding this individual variability, by studying individuals who succeeded and who failed in weight loss maintenance, is crucial to distinguish what works for whom and what does not. The National Weight Control Registry pioneered this type of studies with the purpose of expanding the knowledge on this domain. The main goal of this voluntary registry is to study the characteristics and behavioral strategies used by individuals for achieving and maintaining weight loss, which can possibly help others to achieve successful weight loss and maintenance.[14,15] Following this initiative, and due to cultural specificities, several countries felt the need of implementing similar registries with a broader goal of tackling overweight and obesity and improve their population outcomes. Portugal was one of these countries.[16] Together, these registries provide opportunities for exploring in more depth influential sociodemographic, psychological and behavioral characteristics of successful weight loss maintainers and correlates of successful weight loss maintenance, which is important to inform public health and weight management interventions towards the specific characteristics of the populations and individuals.

# Methods

This systematic review is reported in accordance with MOOSE Guidelines (Meta-analysis of Observational Studies in Epidemiology).[132] Key methodological features of this review were specified in advance and documented in a protocol (PROSPERO International Prospective Register of Systematic Reviews: registration number CRD42019129637; see Appendix A).

## *Eligibility Criteria*

Articles published up to November 2018, in English and Portuguese, were retrieved. Studies were selected for this review if they included samples from weight control registries across the world. Review, perspective and commentary articles were not included, nor articles written in other languages.

## *Search strategy and study selection*

A comprehensive search of peer-reviewed articles (published up to November 2018 or ahead of print) was conducted in three electronic databases: PubMed, Web of Science and Scopus. Searches included various combinations of the following terms: “weight loss maintenance”, “weight control registry”, national weight control registry, Portuguese, Greek, Finnish, German. Additionally, manual cross-referencing of retrieved articles and hand-searches of key scientific journals and the registries websites were performed.

Two authors (CP and IS) screened titles and abstracts of potentially eligible studies. Duplicate entries were removed. Relevant articles were then retrieved for a full-text review. The same two researchers independently reviewed the full-text manuscripts and discrepancies were resolved by consensus. Endnote X7 for Mac OS X was used for reference managing.

## *Quality Assessment*

The methodological quality of included studies was assessed using an adapted version of the Quality Assessment Tool For Quantitative Studies developed by the Effective Public Health Practice Project[133] (Appendix B) and recommended for use by

the Cochrane Public Health Review Group.[134] This tool was previously used in other systematic reviews including observational studies.[(e.g.,24,135)] It addresses seven key domains: 1) study design, 2) selection bias), 3) withdrawals and drop-outs), 4) confounders, 5) data collection, 6) data analysis, and 7) reporting. Each domain was classified as strong, moderate or weak, and a global rating was determined. Two of four researchers (CP, IS, RJ, and EVC) independently rated each of the seven domains and overall quality of each study. Disagreements were resolved by consensus. Inter-rater agreement across categories was moderate (Cohen's kappa = 0.61).

### *Data extraction*

A data extraction form was developed to compile information about i) the weight control registries – specifically, designation, country of origin, year of implementation, sample size, recruitment procedure, period of recruitment, inclusion and exclusion criteria, assessments and instruments used; ii) the participants – specifically, their sociodemographic characteristics (e.g., sex, age, ethnicity, educational level, employment and marital status), weight history (lifetime maximum weight and BMI, baseline weight and BMI, weight loss and period of weight loss maintenance), and the cognitive and behavioral weight control strategies used; and iii) the sociodemographic, behavioral and psychological correlates of weight loss maintenance. Two of four researchers (CP, IS, RJ and EVC) independently extracted the data.

### *Data synthesis*

Registries' characteristics and participants' sociodemographic characteristics, as well as the cognitive and behavioral strategies they used for weight management were qualitatively synthetized and presented in tabular form (Tables 2 and 3, respectively).

Weight management strategies were independently classified within the domains of the Oxford Food and Activity Behaviors (OxFAB) Taxonomy[113] by two of four researchers (CP, IS, RJ, and EVC) and discrepancies were resolved by consensus. This taxonomy was chosen because it is a comprehensive tool to systematically describe the cognitive and behavioral strategies used by individuals attempting to manage their weight.[113] Only the domains including at least one strategy were shown. One additional domain was included – dietary choices – as some of the reported strategies did not fit within any existing domain. Some strategies seemed to fit in more than one domain and therefore we have selected the most appropriate one.

The sociodemographic, behavioral and psychological correlates of the magnitude of weight loss maintenance (expressed in kg or %) were also summarized in tabular form, according to i) the number of studies that assessed each correlate; and ii) the association effect found, namely 'no association', 'positive association', or 'negative association' (Table 4). All associations identified through Pearson and Spearman correlations were considered. In some specific cases, liner and multiple regressions, odds-ratio/relative risk and $\chi^2$ (with post-hoc tests) were also considered.

# Results

The literature search yielded a total of 2,992 records. Twelve articles identified through manual searches and cross-referencing were added, leading to a total of 3,004 potential articles (Figure 1). After duplicates removal (n=1324), 1680 articles were assessed for eligibility. Of these, 1524 were excluded based on title/abstract screening, leaving 156 eligible for full-text screening. Forty-nine articles (published between 1997 and 2018) met eligibility criteria and were included in the present review.

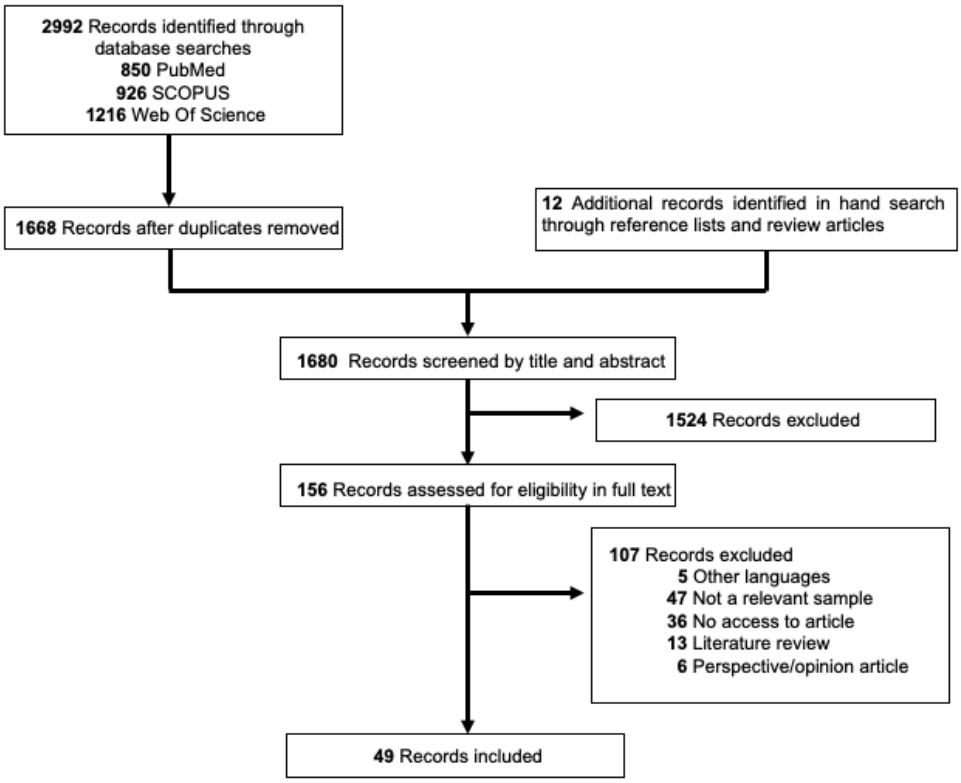


**Figure 1.** Flow diagram of studies.

## *Methodological appraisal*

The overall methodological quality of the 49 included studies was rated as ”moderate” and ”weak” in 45 and 4 studies, respectively. All included studies were rated as moderate regarding study design, as they were all observational studies, and weak regarding selection bias, since registry participants are volunteers and therefore not likely to be representative of the target population. Twelve studies scored moderate on withdrawals and drop-outs and the other 37 were not rated as they had a cross-sectional design. Concerning adjustment for confounders, 2 studies were rated as weak and 47

were rated as strong. Two studies scored weak regarding data collection, as they did not provide information on measures validity or reliability, 2 were classified as moderate and 45 as strong. Most studies (k=48) were classified as strong regarding the use of appropriate statistical analyses and one study was rated as weak, because it did not provide information about the statistical analyses used. All studies but two (which scored moderate) were rated as strong on reporting. For a detailed classification of each domain and overall methodological quality of each study, see Table 1.

**Table 1.** Methodological quality assessment of articles.

| Reference | Study design | Selection bias | Withdrawals and drop-outs | Confounders | Data collection | Data analysis | Reporting | Global |
|---|---|---|---|---|---|---|---|---|
| [14] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [15] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [16] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [17] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [18] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [19] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [136] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [137] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [138] | Moderate | Weak | Moderate | Strong | Strong | Strong | Strong | **Moderate** |
| [139] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [140] | Moderate | Weak | Moderate | Strong | Strong | Strong | Strong | **Moderate** |
| [141] | Moderate | Weak | Moderate | Strong | Strong | Strong | Strong | **Moderate** |
| [142] | Moderate | Weak | Moderate | Strong | Strong | Strong | Strong | **Moderate** |

**Table 1.** Methodological quality assessment of articles (Continued).

| Reference | Study design | Selection bias | Withdrawals and drop-outs | Confounders | Data collection | Data analysis | Reporting | Global |
|---|---|---|---|---|---|---|---|---|
| [143] | Moderate | Weak | No rating | Strong | Strong | Strong | Moderate | **Moderate** |
| [144] | Moderate | Weak | Moderate | Strong | Strong | Strong | Strong | **Moderate** |
| [145] | Moderate | Weak | Moderate | Strong | Strong | Strong | Strong | **Moderate** |
| [146] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [147] | Moderate | Weak | Moderate | Strong | Strong | Strong | Strong | **Moderate** |
| [148] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [149] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [150] | Moderate | Weak | Moderate | Strong | Strong | Strong | Strong | **Moderate** |
| [151] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [152] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [153] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [154] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [155] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [156] | Moderate | Weak | Moderate | Strong | Strong | Strong | Strong | **Moderate** |

**Table 1.** Methodological quality assessment of articles (Continued).

| Reference | Study design | Selection bias | Withdrawals and drop-outs | Confounders | Data collection | Data analysis | Reporting | Global |
|---|---|---|---|---|---|---|---|---|
| [157] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [158] | Moderate | Weak | Moderate | Strong | Strong | Strong | Strong | **Moderate** |
| [159] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [160] | Moderate | Weak | No rating | Strong | Strong | Strong | Moderate | **Moderate** |
| [161] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [162] | Moderate | Weak | No rating | Strong | Strong | Weak | Strong | **Weak** |
| [163] | Moderate | Weak | Moderate | Strong | Moderate | Strong | Strong | **Moderate** |
| [164] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [165] | Moderate | Weak | No rating | Weak | Strong | Strong | Strong | **Weak** |
| [166] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [167] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [168] | Moderate | Weak | No rating | Strong | Moderate | Strong | Strong | **Moderate** |
| [169] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [170] | Moderate | Weak | Moderate | Strong | Strong | Strong | Strong | **Moderate** |

**Table 1.** Methodological quality assessment of articles (Continued).

| Reference | Study design | Selection bias | Withdrawals and drop-outs | Confounders | Data collection | Data analysis | Reporting | Global |
|---|---|---|---|---|---|---|---|---|
| [171] | Moderate | Weak | No rating | Weak | Weak | Strong | Strong | **Weak** |
| [172] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [173] | Moderate | Weak | No rating | Strong | Weak | Strong | Strong | **Weak** |
| [174] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [175] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [176] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [177] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |
| [178] | Moderate | Weak | No rating | Strong | Strong | Strong | Strong | **Moderate** |

### *Weight control registries' and participants' characteristics*

Characteristics of the five weight control registries found, and the sociodemographic characteristics of their participants are summarized in Table 2. The first one was implemented in the United States of America (US) in 1993, while the other ones were implemented between 2008 and 2012 across 4 European countries. The US registry has the largest known sample size (n>10,000) and participants are mainly middle-aged women.

Regarding participants' weight history, lifetime maximum BMI ranged between 32.4 and 36.3 kg/m$^2$ across registries and at baseline between 25.0 and 30.1 kg/m$^2$. Average weight loss at study entry varied between 14.5 and 32.4 kg, and was maintained for 28-68 months.

Recruitment procedures, use of incentives, and eligibility criteria slightly differed between registries. Across the 5 registries, age (≥ 18 years old) was a common requisite for entering. The required weight loss, however, differed between them. Germany, Finland and Greece requested an initial weight loss of at least 10%, whereas Portugal and the US established a weight loss of at least 5 kg and 13.6 kg (30 lb), respectively. Some registries (Germany, Finland, Greece) also established as a criterion having excess weight prior to weight loss. All weight control registries required maintaining the weight lost for at least 1 year, except the Finnish registry that required, at least, 2 years of weight loss maintenance. The MedWeight study (Greece) has another particularity: it includes both maintainers and regainers, i.e., people that have lost weight but regained some part of it. Additionally, the frequency and methods of assessments also differed between registries. The Finnish registry has a single assessment moment, while the others have at least two assessment moments, being the US registry the one that assesses participants more often (annually for 10 years). All registries collect information on sociodemographics, lifestyle habits, personal and/or familiar medical history, and psychometrics. They all include some kind of dietary intake and structured physical activity measurement, except the Finnish one. Anthropometric data are generally self-reported, except in the Portuguese registry where individuals are objectively measured (weight, height and waist circumference).

**Table 2.** Weight control registries' and participants' characteristics.

| Designation | National Weight Control Registry (NWCR) [14,15,136-164] | Portuguese Weight Control Registry (PWCR) [16,165-167] | German Weight Control Registry (GWCR) [18,168-170] | Finnish Weight Control Registry (FWCR) [17,171-173] | MedWeight [19,174-178] |
|---|---|---|---|---|---|
| **Weight control registries' characteristics** | | | | | |
| **Country** | United States | Portugal | Germany | Finland | Greece |
| **Number of published articles** | 31 | 4 | 4 | 4 | 6 |
| **Year of implementation** | 1993 | 2008 | 2009 | 2012 | 2012 |
| **Participants' sociodemographic characteristics*** | | | | | |
| **Maximum sample size reported** | 5320[156 ∂] | 388[166א] | 494[18] | 158[17] | 528[174ζ] |
| **Sex (% female)** | 75.0 | 63.4 | 60.7 | 63.3 | 61.0 |
| **Age (years)** | 47.0 ± 12.2 | 39.0 ± 11.1 | 47.6 ± 12.7 | 44.5 ± 11.0 | Maintainers: 29 (24-38)<br>Regainers: 37 (29-45) |
| **Ethnicity (% white)** | 95.0 | - | - | - | - |
| **Education (% higher)** | 85.0 (college) | 69.1 (university degree) | 46.8 (academic degree) (n=492) | 22.8 (> 14y of school) | 16.0 ± 3.0 y of school (n=411)[176] |
| **Employment (% employed)** | 74.0 (n=1422)[140] | 78.7 (n=198)[16] | 76.9 (n=489) | 76.6 | Maintainers: 52 (n=289)<br>Regainers: 62 (n=122)[176] |
| **Marital Status (%married/union)** | 67.9 (n=3683)[136] | 54.6 | 81.6 (n=490) | 72.8 | Maintainers: 20 (n=289)<br>Regainers: 43 (n=122)[176] |

**Table 2.** Weight control registries' and participants' characteristics (Continued).

| Designation | National Weight Control Registry (NWCR) [14,15,136-164] | Portuguese Weight Control Registry (PWCR) [16,165-167] | German Weight Control Registry (GWCR) [18,168-170] | Finnish Weight Control Registry (FWCR) [17,171-173] | MedWeight [19,174-178] |
|---|---|---|---|---|---|
| **Participants' weight history*** | | | | | |
| **Lifetime maximum weight (kg)** | 103.8 ± 25.9 (n=3683)[136] | 92.5 ± 20.4 (n=225) | - | - | 90.0 (80.0-105.0) (n=239)[178] |
| **Lifetime maximum BMI (kg/m$^2$)** | 36.3 ± 8.1 (n=3683)[136] | 33.1 ± 6.4 (n=225) | 33.2 ± 6.5 | 35.9 (range 29.2–64.8) | Maintainers: 33.1 ± 6.9<br>Regainers: 32.4 ± 5.2 (n=411)[176] |
| **Weight at baseline (kg)** | 71.5 ± 15.9 (n=3683)[136] | 74.1 ± 13.4 (n=225) | - | - | 78.1 ± 16.5 (n=239)[178] |
| **BMI at baseline (kg/m$^2$)** | 25.1 ± 4.5 | 26.6 ± 4.2 (n=225) | 25.7 ± 4.2 | 26.1 (range 17.3 – 41.2) | Maintainers: 25.0 (22.8-28.1)<br>Regainers: 30.1 (27.6-34.3) |
| **Weight loss at baseline (kg)** | 32.3 ± 16.7 (n=3683)[136] | 18.3 ± 12.5 (n=225) | - | 32.4 (range 9–81) | Maintainers: 25.6 ± 15.8<br>Regainers: 14.5 ± 4.5 (n=226)[19] |
| **Duration of weight loss maintenance at baseline** | 68.3 ± 88.1 months (n=3683)[136] | 28.3 ± 29.6 months (n=225) | 5.6 ± 5.8 years (n=381)[169] | 53.2% (2 to 3 years);<br>20.3% (4 to 5 years);<br>15.8% (6 to 8 years);<br>10.7% (≥9 years). | 4.6 ± 4.3 years (only the group of maintainers) (n=169)[19] |
| **Weight Control Registries' Procedures** | | | | | |
| **Period of recruitment** | Ongoing | Ongoing | October 2009 - April 2011 | January 2012 – August 2013 | Ongoing |

**Table 2.** Weight control registries' and participants' characteristics (Continued).

| **Designation** | **National Weight Control Registry (NWCR)** [14,15,136-164] | **Portuguese Weight Control Registry (PWCR)** [16,165-167] | **German Weight Control Registry (GWCR)** [18,168-170] | **Finnish Weight Control Registry (FWCR)** [17,171-173] | **MedWeight** [19,174-178] |
|---|---|---|---|---|---|
| **Weight Control Registries' Procedures (Continued)** | | | | | |
| **Recruitment procedure** | Local media (newspapers, magazines, radio, and television); physician and dietitian referrals; mailing lists of commercial weight loss programs. Website: http://www.nwcr.ws** | Local and social media (newspapers, radio, television, Facebook); partnership with the General Directorate-General of Health and with gyms/health clubs/companies. Website: http://panosr.fmh.ulisboa.pt/rncp | Local media (press conferences, broad publicity campaign) | Local media (newspapers and magazines); healthcare centers and hospitals. Website: http://www.sphr.fi** | Local and social media. Website; http://medweight.hua.gr |
| **Rewards for participation** | To improve the 3-year response rate, individuals who did not complete the full assessment battery were sent $5 and asked to report their weight. | No | A financial compensation was offered for follow-up measurements. | No[⊥] | No |

**Table 2.** Weight control registries' and participants' characteristics (Continued).

| Designation | National Weight Control Registry (NWCR) [14,15,136-164] | Portuguese Weight Control Registry (PWCR) [16,165-167] | German Weight Control Registry (GWCR) [18,168-170] | Finnish Weight Control Registry (FWCR) [17,171-173] | MedWeight [19,174-178] |
|---|---|---|---|---|---|
| **Weight Control Registries' Procedures (Continued)** | | | | | |
| **Eligibility screening** | Online/e-mail/telephone registration; telephone screening questionnaire; contact of a health professional, family member, or friend who could confirm participants' weight loss, or before-and-after weight loss pictures. | Online/e-mail/telephone registration; telephone screening questionnaire; contact of a health professional, family member, or friend who could confirm participants' weight loss, or before-and-after weight loss pictures. | Telephone/letter or online screening questionnaire | Online screening questionnaire; participants' weight history could be confirmed (if necessary) through their healthcare system/network$^{\perp}$ | Online screening questionnaire |
| **Inclusion criteria** | i) ≥18 years;<br>ii) must have maintained a weight loss of ≥13.6 kg (30 lb) for ≥1 year.$^{\omega}$ | i) Portuguese nationality;<br>ii) 18-65 years;<br>iii) maintained ≥5kg intentional weight loss (on the last 15 years of their adult lives) for ≥1 year (independently of their initial body weight).$^{\omega}$ | i) ≥18 years;<br>ii) lifetime maximum weight corresponding to BMI ≥ 30 kg/m$^2$ (excluding pregnancy);<br>iii) intentionally lost ≥ 10% of their maximum weight at any time of their lives and maintained it for ≥1 year.$^{\omega}$ | i) 18-60 years;<br>ii) BMI ≥ 30 kg/m$^2$ before initiating weight loss;<br>iii) weight loss ≥10% lasting ≥2 years.$^{\omega}$ | i) 18-65 years;<br>ii) maximum BMI ≥ 25 kg/m$^2$;<br>iii) intentionally lost ≥10% of their starting weight (maintainers = ≥10% for ≥1 year; regainers = currently at a weight ≥95% of their maximum body weight).$^{\omega}$ |
| **Exclusion criteria** | - | i) BMI <18,5 Kg/m$^2$ (after weight loss) | - | i) Bariatric surgery;<br>ii) Drug treatment for obesity | i) Body weight between 90–95% of their maximum weight;<br>ii) Pregnancy |

**Table 2.** Weight control registries' and participants' characteristics (Continued).

| Designation | National Weight Control Registry (NWCR) [14,15,136-164] | Portuguese Weight Control Registry (PWCR) [16,165-167] | German Weight Control Registry (GWCR) [18,168-170] | Finnish Weight Control Registry (FWCR) [17,171-173] | MedWeight [19,174-178] |
|---|---|---|---|---|---|
| **Weight Control Registries' Procedures (Continued)** | | | | | |
| **Informed consent form** | Yes | Yes | Yes | Yes | Yes |
| **Ethical approval** | Yes. By the Miriam Hospital Institutional Review Board for the Protection of Human Subjects in Research. | Yes. By the Ethics Committee of the Faculty of Human Kinetics, University of Lisbon. | Yes. By the Ethics Committee of the Medical School at the University of Erlangen-Nuremberg. | Yes. By the Ethics Committee, Department of Medicine, Helsinki University Hospital. | Yes. By the Harokopio University Ethics Committee. |
| **Assessments and instruments (baseline)*** ** | | | | | |
| **Assessments (frequency)** | Annually (for 5y). Participants may optionally re-consent to providing another 5y of self-reported weight change only. | Baseline + 1y follow-up | Baseline + 1y + 2y follow-up | Baseline | Baseline + 1y + 5y[⊥] follow-up |
| **Assessments (format)** | Offsite; Online[⊥] or paper form | Onsite or offsite (when participants were not able to go to the site); Paper form | Offsite; Online (secuTrial software) or paper form | Offsite; Online (individualized link) | Offsite; Online |

**Table 2.** Weight control registries' and participants' characteristics (Continued).

| Designation | National Weight Control Registry (NWCR) [14,15,136-164] | Portuguese Weight Control Registry (PWCR) [16,165-167] | German Weight Control Registry (GWCR) [18,168-170] | Finnish Weight Control Registry (FWCR) [17,171-173] | MedWeight [19,174-178] |
|---|---|---|---|---|---|
| **Assessments and instruments (baseline)*** (Continued)** | | | | | |
| **Participant characterization** | i) Sociodemographic information (e.g., age, sex, education level, marital status, ethnicity);<br>ii) Weight history (age at onset of overweight, parental and sibling weight status, maximum lifetime weight, current weight, and duration of the required minimum weight loss);<br>iii) Health history;<br>iv) Weight History Timeline (to assess weight changes);<br>v) Weight loss and weight maintenance strategies. | i) Sociodemographic information (e.g., age, sex, marital status, employment status, education level, smoking status);<br>ii) Weight history (family weight history, previous weight loss attempts; motives and triggers to lose weight);<br>iii) Health history;⊥<br>iv) Weight History Timeline (to assess weight changes);⊥<br>v) Weight loss and weight maintenance strategies. | i) Sociodemographic data (e.g., age, sex, partnership, employment status, education level);<br>ii) Weight history;<br>iii) Weight loss strategies;<br>iv) Reasons for weight loss;<br>v) Weight cycling;<br>vi) Frequency of weighing;<br>vii) Medical co-morbidity; Health care utilization;<br>viii) Obesity attribution;<br>ix) Eating and weighing habits. | i) Sociodemographic information (e.g., age, sex, marital status, size of household, type of accommodation, education, work, earnings, religion, if the participant is a woman: number of children, menstruation started/ended);<br>ii) Weight history (history of weight loss attempts/ methods; motivational factors);<br>iii) General health (medication, participant and relatives' diseases, subjective health);<br>iv) Lifestyle habits (smoking habit, alcohol consumption, sleep, leisure time, physical activity); | i) Sociodemographic information (e.g., age, sex, education level, marital status, employment status, type of occupation, type of residence area, siblings);<br>ii) Weight history (weight loss methods, weight loss and maintenance motives, frequency of self-weighing, history of overweight during childhood/adolescence);<br>iii) Previous body weight cycles - 25-item **Weight Cycling Questionnaire**;<br>iv) Medical history (including gastrointestinal function); |

**Table 2.** Weight control registries' and participants' characteristics (Continued).

| Designation | National Weight Control Registry (NWCR) [14,15,136-164] | Portuguese Weight Control Registry (PWCR) [16,165-167] | German Weight Control Registry (GWCR) [18,168-170] | Finnish Weight Control Registry (FWCR) [17,171-173] | MedWeight [19,174-178] |
|---|---|---|---|---|---|
| **Assessments and instruments (baseline)*** (Continued)** | | | | | |
| **Participant characterization (Continued)** | | | | v) Changes in diet, eating habit, exercise, weighing;<br>vi) Knowledge (health risks, nutritional content and energy intake);<br>vii) Difficulties and support during weight loss and maintenance. | v) Lifestyle habits (Smoking status, sleep quality assessed through the validated Greek version of the **Athens Insomnia Scale – AIS,** frequency of leisure time activities and socializing);<br>vi) Dietary behaviors (eating rate, involvement in meal preparation). |
| **Psychometry** | i) Depressive symptoms – **Center for Epidemiological Studies Depression Scale (CES-D)**;<br>ii) Stressful situations appraisal – **Perceived Stress Scale (PSS4)**;<br>iii) Frequency of objective binge eating episodes over the previous 28 days – **Eating Disorder Examination-Questionnaire (EDE-Q)**; | i) General health-related quality of life – **Short-Form Health-Related Quality of Life (SF-36)**;<br>ii) Weight-related quality of life – **Impact of Weight on Quality of Life (IWQOL)**;<br>iii) Self-esteem – **Rosenberg Self-Concept/Self-Esteem Scale**; | i) Weight-specific measure of health-related quality of life – **Impact of Weight on Quality-of-Life-Lite Scale**;<br>ii) Depressive and somatic symptoms – subscales of the German version of **Patient Health Questionnaire (PHQ-D)**;<br>iii) Impulsivity – **Barrett Impulsiveness Scale**; | i) **Finnish version of the Ten Item Personality Inventory (TIPI)** to measure personality traits according to the FFM5. | i) Personality traits – **Ten Item personality Traits (TIPI)**;<br>ii) Trait of impulsivity – validated Greek version of the **Barratt Impulsiveness Scale (BIS)**;<br>iii) Perceived control of weight status/fluctuations – **Multidimensional Health Locus of Control - MHLC scales**; |

**Table 2.** Weight control registries' and participants' characteristics (Continued).

| Designation | National Weight Control Registry (NWCR) [14,15,136-164] | Portuguese Weight Control Registry (PWCR) [16,165-167] | German Weight Control Registry (GWCR) [18,168-170] | Finnish Weight Control Registry (FWCR) [17,171-173] | MedWeight [19,174-178] |
|---|---|---|---|---|---|
| **Assessments and instruments (baseline)*** (Continued)** | | | | | |
| **Psychometry (Continued)** | iv) Psychiatric symptoms – **General Symptom Index (Symptom Checklist-90 Revised – SCL-90-R)**;<br>v) Eating behavior (cognitive restraint, disinhibition and hunger) – **Eating Inventory/ Three-Factor Eating Questionnaire.** | iv) Body image dissatisfaction – **Body Image Assessment Questionnaire (BIA)**;<br>v) Experience of and preoccupation with being fat – **Body Shape Questionnaire (BSQ)**;<br>vi) Exercise motivation – **Intrinsic Motivation Inventory (IMI)**;<br>vii) Self-efficacy for exercise – **Exercise Self-Efficacy Questionnaire (ESE)**;<br>viii) Social support for exercise – **Exercise Social Support (ESS);**<br>ix) External, introjected, identified and intrinsic forms of regulation for exercise behavior – **Behavioral Regulation in Exercise Questionnaire (BREQ-2)**; | iv) Social support – seven-item short form **Social Support Questionnaire (F-Sozu-7)**;<br>v) Retrospective effect of weight-related teasing – **Effect Subscale of the German version of the Perception of Teasing Scale (POTS)**;<br>vi) Non-normative eating behaviors and eating-related psychopathology – **Eating Disorder Examination-Questionnaire (EDE-Q);**<br>vii) Eating behavior (restrained eating, emotional eating and external eating) – **Dutch Eating Behavior Questionnaire (DEBQ).** | | iv) Social support – **Social support for Healthy Behaviors scale.** |

**Table 2.** Weight control registries' and participants' characteristics (Continued).

| Designation | National Weight Control Registry (NWCR) [14,15,136-164] | Portuguese Weight Control Registry (PWCR) [16,165-167] | German Weight Control Registry (GWCR) [18,168-170] | Finnish Weight Control Registry (FWCR) [17,171-173] | MedWeight [19,174-178] |
|---|---|---|---|---|---|
| **Assessments and instruments (baseline)*** (Continued)** | | | | | |
| **Psychometry (Continued)** | | x) Eating behavior (cognitive restraint, disinhibition and perceived hunger) – **Eating Inventory/ Three-Factor Eating Questionnaire**;<br>xi) Eating behavior (restrained eating, emotional eating and external eating) – **Dutch Eating Behavior Questionnaire (DEBQ);**<br>xii) Stress response – **Coping Questionnaire (COPE)**;<br>xiii) Depressive symptoms – **Beck Depression Inventory (BDI)**;<br>xiv) Social and physical anxiety – **Social Physique Anxiety Scale**; | | | |

**Table 2.** Weight control registries' and participants' characteristics (Continued).

| Designation | National Weight Control Registry (NWCR) [14,15,136-164] | Portuguese Weight Control Registry (PWCR) [16,165-167] | German Weight Control Registry (GWCR) [18,168-170] | Finnish Weight Control Registry (FWCR) [17,171-173] | MedWeight [19,174-178] |
|---|---|---|---|---|---|
| **Assessments and instruments (baseline)*** (Continued)** | | | | | |
| **Psychometry (Continued)** | | xv) Self-determined way of functioning – **Self Determination Scale**; xvi) Basic needs satisfaction in general – **Basic Need Satisfaction Scale (BNS)**. | | | |
| **Dietary intake** | Total energy intake (kcals/day), macronutrients (fat, carbohydrates and protein) and micronutrients intake – **Block Food Frequency Questionnaire** | Total energy intake (kcals/day) and macronutrients (fat, carbohydrates and protein) and micronutrients intake – **Semi-quantitative food-frequency questionnaire** | Food intake structure questionnaire; Hedonics of food intake[⊥] | - | Total energy intake (kcals/day), macronutrients (fat, carbohydrates and protein) intake; food groups intake, adherence to the Mediterranean diet, meal patterns and environmental aspects of the meal – Two telephone **24-h dietary recalls** (conducted 10 days apart, weekdays and weekends). |

**Table 2.** Weight control registries' and participants' characteristics (Continued).

| Designation | National Weight Control Registry (NWCR) [14,15,136-164] | Portuguese Weight Control Registry (PWCR) [16,165-167] | German Weight Control Registry (GWCR) [18,168-170] | Finnish Weight Control Registry (FWCR) [17,171-173] | MedWeight [19,174-178] |
|---|---|---|---|---|---|
| **Assessments and instruments (baseline)*** (Continued)** | | | | | |
| **Physical Activity** | Minutes of light, moderate and vigorous physical activity, sedentary activities, sleep – **Paffenbarger Physical Activity Questionnaire** | Minutes of light, moderate and vigorous physical activity, lifestyle physical activity, sedentary activities, sleep: i) **Accelerometry;** ii) **Paffenbarger Physical Activity Questionnaire;** iii) **Seven-day Physical Activity Recall;** iv) **Lifestyle Physical Activity Index.** | Minutes of walking, moderate and vigorous physical activity, sedentary activities – **International Physical Activity Questionnaire**[⊥] | - | Minutes of walking moderate and vigorous physical activity, sedentary activities – Greek short version of the **International Physical Activity Questionnaire (IPAQ)** |
| **Anthropometry** | Self-reported weight and height | Objectively measured weight, height and waist circumference (if assessments are onsite) | Self-reported weight and height | Self-reported weight and height | Self-reported weight and height |

[∂] Maximum sample size known is over 10,000 participants; [ϰ] Maximum sample size known is 402 participants; [ζ] Maximum sample size known is 756 participants; [ω] Weight and weight loss are self-reported by the participants; [⊥] This information was provided by the Principal Investigator of the weight control registry. *Participants' characterization is reported using data from the reference with the larger sample size (unless it is indicated); **Websites were provided as an extra information, even they were not part of the recruitment procedure; *** Follow-up assessments differ from baseline and will not be reported as there is not much information, or it is somehow contradictory.

### *Cognitive and behavioral weight management strategies*

Thirteen studies across 4 countries reported strategies used by weight control registries' participants for weight loss and maintenance (Table 3). Fifty-one strategies, grouped in 14 domains of the OxFAB Taxonomy, were identified.

The most reported strategies (≥ 80%) for *weight loss* were classified in the following domains: *planning content* (having healthy foods available at home), *dietary choices* (regular breakfast intake and increase vegetables consumption), *energy compensation* (doing physical activity/exercise), and *regulation (restrictions)* (reduce the consumption of sugary foods, fatty foods, and reduce fat in meals) domains. The least reported strategies (≤ 20%) were hypnosis, having help from a weight control group, and help from a personal trainer or other professionals – classified in the *support (professional)* domain; surgery, taking weight loss medication, using meal substitutes, and consuming weight loss supplements – classified in the *weight management aids* domain; seeking weight loss information online – classified in the *information seeking* domain; and limiting intake to only 1 or 2 types of food and follow a special or fad diet – within the *regulation (restrictions)* domain.

Regarding *weight loss maintenance*, the great majority of participants (≥ 80%) relied on regular breakfast intake, increasing the consumption of vegetables and fiber-rich foods – classified in the *dietary choices* domain; limiting intake of certain types of foods, reducing the consumption of fatty and sugary foods, and reducing fat in meals – classified in the *regulation (restrictions*) domain; having healthy foods and few high-fat foods available at home – within the *planning content* domain; and having a regular meal frequency – within the *regulation (rule setting)* domain. Less than 20% of participants reported taking weight loss medication, using meal substitutes, and consuming weight loss supplements – classified in the *weight management aids* domain; avoiding overweight friends and following a special or fad diet – within the *regulation (restrictions)* domain; spending more time with normal-weight friends – within the *regulation (rule setting)* domain; and having help from a weight control group – classified in the *support (professional)* domain.

**Table 3.** Cognitive and behavioral weight management strategies used by participants of weight control registries.

| **Domains** Strategies | **Weight loss strategies** | | | | **Weight loss maintenance strategies** | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of studies | n | Prevalence (%) | References | Number of studies | n | Prevalence (%) | References |
| **Dietary choices** | | | | | | | | |
| Increase vegetables consumption | 2 | 546 | 86.6 | 166,173 | 1 | 388 | 88.8 | 166 |
| Regular breakfast intake[§141] | 1 | 388 | 89.7 | 166 | 1 | 388 | 96.6 | 166 |
| Regular soup intake | 1 | 388 | 50.5 | 166 | 1 | 388 | 50.3 | 166 |
| Increase protein-rich foods consumption (e.g., eggs, fish, meat)[§166] | 1 | 388 | 36.1 | 166 | 1 | 388 | 43.5 | 166 |
| Increase fiber-rich foods consumption | 1 | 388 | 77.1 | 166 | 1 | 388 | 83.6 | 166 |
| **Energy compensation*** | | | | | | | | |
| Physical activity/Exercise[Ω] | 3 | 3683 | 88.6 | 14,136,137 | 1 | 388 | 67.5 | 166 |
| Using stairs rather than elevators | 1 | 388 | 45.6 | 166 | 0 | - | - | - |
| Walk instead of driving/taking public transportation[§166] | 1 | 388 | 37.9 | 166 | 0 | - | - | - |
| Parking away from destination | 1 | 388 | 20.4 | 166 | 0 | - | - | - |
| **Goal setting** | | | | | | | | |
| Establishing specific goals (e.g., regarding weight loss, physical activity)[§166] | 1 | 388 | 60.6 | 166 | 1 | 388 | 49.1 | 166 |
| **Imitation (modeling)** | | | | | | | | |
| Followed a diet program (obtained from a fad book, magazine or another person)[⊕] | 2 | 2964 | 23.6 | 19,155 | 0 | - | - | - |
| **Information seeking** | | | | | | | | |
| Conscious food selection (e.g., read labels) | 1 | 388 | 79.9 | 166 | 1 | 388 | 72.7 | 166 |
| Seek weight loss information online | 1 | 158 | 4.4 | 171 | 0 | - | - | - |
| Diet/exercise books/magazines | 0 | - | - | - | 1 | 2228 | 72.4 | 137 |
| **Motivation** | | | | | | | | |
| Kept picture of self in a prominent place | 0 | - | - | - | 1 | 931 | 23.6 | 148 |
| Lost weight by self[⊕] | 1 | - | - | 19 | 0 | - | - | - |

**Table 3.** Cognitive and behavioral weight management strategies used by participants of weight control registries (Continued).

| **Domains** Strategies | **Weight loss strategies** | | | | **Weight loss maintenance strategies** | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of studies | n | Prevalence (%) | References | Number of studies | n | Prevalence (%) | References |
| **Planning content** | | | | | | | | |
| Healthy foods available at home (e.g., fruits, vegetables)[§166ø] | 1 | 388 | 92.8 | 166 | 2 | 1319 | 89.7 | 148,166 |
| Few high-fat foods available at home | 0 | - | - | - | 1 | 931 | 83.2 | 148 |
| **Regulation: Restrictions** | | | | | | | | |
| Follow a special/fad diet[⊕] | 3 | 1664 | 16.2 | 14,19,138 | 1 | 893 | 17.0 | 143 |
| Reduce portion sizes[§166] | 2 | 546 | 72.5 | 166,173 | 1 | 388 | 64.6 | 166 |
| Decrease alcohol intake | 1 | 158 | 34.8 | 173 | 0 | - | - | - |
| Decrease intake of soft drinks | 1 | 158 | 53.8 | 173 | 0 | - | - | - |
| Limit intake of certain types of foods | 1 | 891 | 74.0 | 138 | 1 | 893 | 93.1 | 143 |
| Limit intake to only 1 or 2 types of foods | 1 | 891 | 6.1 | 138 | | | | |
| Limit percentage of daily energy from fat | 1 | 773 | 33.1 | 14 | 1 | 893 | 37.8 | 143 |
| Reduce/eliminate carbohydrates-rich foods (e.g., rice, pasta, bread)[§166] | 1 | 388 | 47.9 | 166 | 1 | 388 | 35.4 | 166 |
| Reduce sugary foods[◦ §166ø] | 2 | 388 | 86.6 | 166,173 | 1 | 388 | 84.1 | 166 |
| Reduce fatty foods[∪] | 2 | 388 | 86.6 | 166,173 | 1 | 388 | 86.0 | 166 |
| Reduce fat in meals/confection/seasoning | 1 | 388 | 84.0 | 166 | 1 | 388 | 83.8 | 166 |
| Replace caloric sauces for less-caloric alternatives (e.g., squeezed lemon juice) | 1 | 388 | 66.2 | 166 | 1 | 388 | 69.8 | 166 |
| Decrease meals at restaurants | 1 | 388 | 45.4 | 166 | 2 | 1319 | 30.6 | 148,166 |
| Avoided overweight friends | 0 | - | - | - | 1 | 931 | 4.0 | 148 |
| **Regulation: Rule setting** | | | | | | | | |
| Regular meal frequency | 2 | 546 | 72.5 | 166,173 | 1 | 388 | 80.8 | 166 |
| Spent more time with normal-weight friends | 0 | - | - | - | 1 | 931 | 7.4 | 148 |
| Spent more time with friends who exercise | 0 | - | - | - | 1 | 931 | 24.8 | 148 |

**Table 3.** Cognitive and behavioral weight management strategies used by participants of weight control registries (Continued).

| **Domains** Strategies | **Weight loss strategies** | | | | **Weight loss maintenance strategies** | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of studies | n | Prevalence (%) | References | Number of studies | n | Prevalence (%) | References |
| **Restraint** | | | | | | | | |
| Decrease the quantity of all types of food eaten | 1 | 891 | 57.8 | 138 | 1 | 893 | 50.5 | 143 |
| **Self-monitoring** | | | | | | | | |
| Count calories | 2 | 1279 | 27.7 | 138,166 | 2 | 1281 | 28.6 | 143,166 |
| Count fat grams | 1 | 891 | 26.7 | 138 | 1 | 893 | 31.1 | 143 |
| Self-weighing[§144,163,166] | 1 | 388 | 74.5 | 166 | 2 | 1129 | 72.9 | 148,165 |
| Record dietary intake/physical activity[§166ø] | 1 | 388 | 27.3 | 166 | 2 | 1319 | 35.9 | 148,166 |
| **Support: Motivational** | | | | | | | | |
| Support from family | 0 | - | - | - | 1 | 158 | 63.9 | 171 |
| Support from friends | 0 | - | - | - | 1 | 158 | 49.4 | 171 |
| **Support: Professional** | | | | | | | | |
| Attend a weight control program | 3 | 3162 | 37.6 | 19,155,165 | 1 | 2228 | 32.9 | 137 |
| Self-help/weight control group | 3 | 3320 | 8.0 | 155,165,171 | 1 | 158 | 19.6 | 171 |
| Advice from a healthcare professional[**⊕∠] | 4 | 826 | 46.0 | 19,147,155,171 | 1 | 158 | 31.0 | 171 |
| Help from a personal trainer/other professionals[⊕] | 3 | 3122 | 11.4 | 19,155,171 | 0 | - | - | - |
| Hypnosis | 1 | 2228 | 1.2 | 137 | 0 | - | - | - |
| **Weight management aids** | | | | | | | | |
| Meal substitutes (e.g., shakes, bars)[⊕] | 3 | 1281 | 13.8 | 19,143,166 | 2 | 1281 | 7.2 | 143,166 |
| Weight loss medication[⊕] | 2 | 2964 | 7.3 | 19,155 | 1 | 2228 | 1.0 | 137 |
| Surgery[⊕] | 2 | 2228 | 3.7 | 19,137 | 0 | - | - | - |
| Weight loss supplements[▽166] | 1 | 388 | 15.2 | 166 | 1 | 388 | 11.5 | 166 |

*Physical activity was considered in the Energy Compensation domain because this strategy is commonly used to compensate energy intake as a way to control weight; **Assisted weight loss was interpreted as receiving advice from a healthcare professional.
§ This strategy was found to be positively associated with weight control (either loss, maintenance or both) in terms of magnitude (reference of the article/s); ▽ This strategy was found to be negatively associated with weight control (either loss, maintenance or both) in terms of magnitude (reference of the article/s); ø Association observed only in women
Ω Studies [137] and [14] were not accounted for sample size or prevalence rates because of assessment differences (separate non-mutually exclusive values for exercising at home, with friends or with a structured group).
⊕ Study [19] was not accounted for sample size or prevalence rates because the exact frequencies were not reported.
° Study [173] was not accounted for sample size or prevalence rates because of assessment differences (separate non-mutually exclusive values for candies, sweet pastries and fast carbohydrates).
◡ Study [173] was not accounted for sample size or prevalence rates because of assessment differences (separate non-mutually exclusive values for fast food, high-fatty cold cuts/sausages and high-fatty cheeses).
∠ Study [155] was not accounted for sample size or prevalence rates because of assessment differences (separate non-mutually exclusive values for advice from different health care professionals).

### *Correlates of the magnitude of weight loss maintenance*

Table 4 shows a data analytic synthesis of the 34 sociodemographic, behavioral and psychological correlates of the magnitude of weight loss maintenance tested in 19 of 49 studies. Physical activity was the most frequently studied correlate (k = 5) with all of the studies reporting a positive association with the magnitude of weight loss maintenance. Energy intake and fat intake were tested as correlates of the magnitude of weight loss maintenance in 3 studies each, with higher energy and fat intake being identified as negative predictors of magnitude of weight loss maintenance in all of the studies. The amount of sustained weight loss prior to study entry was also tested as a correlate of the magnitude of weight loss maintenance at follow-up (k=3): 33% of participants showed a greater magnitude of sustained weight loss at follow-up.

The duration of weight loss maintenance before entering the registry was tested in 3 studies, with all showing positive associations with the magnitude of weight loss maintenance. General eating disinhibition (k=3) and internal and external disinhibition (k=2) were also tested as correlates of the magnitude of weight loss maintenance, with general and internal eating disinhibition being identified as consistent negative correlates. Several variables were identified as positive correlates of the magnitude of weight loss maintenance, although generally in less than 3 studies: body weight, lifetime maximum body weight, medical trigger, protein and carbohydrates intake, having a healthy eating pattern, sleep quality, dieting consistency, neuroticism, conscientiousness, and an internal locus of control (Table 4); regular breakfast intake, increasing protein-rich foods' consumption, walking instead of driving/taking public transportation, establishing specific goals, reducing portions size, reducing/eliminating carbohydrates-rich foods, and self-weighing (Table 3). The following strategies were associated with the magnitude of weight loss maintenance only in women: having healthy foods available at home, reducing sugary foods and recording dietary intake/physical activity (Table 3).

**Table 4.** Association of sociodemographic, behavioral, and psychological characteristics with the magnitude of weight loss maintenance.

| Correlates | Magnitude of weight loss maintenance | | | |
|---|---|---|---|---|
| | Number of studies | No association | Significant association | |
| | | | Positive | Negative |
| ***Sociodemographic*** | | | | |
| Socioeconomic status | 1 | 173[a⊥] | | |
| Level of education | 1 | 163[f] | | |
| Ethnic/racial background | 1 | 163[af] | | |
| Age | 1 | | | 141[b] |
| *Weight history* | | | | |
| Body weight | 1 | | 141[b] | |
| Lifetime maximum body weight | 1 | | 163[f] | |
| Magnitude of initial weight loss | 3 | | 163[f] | 141[b] 147[b] |
| Duration of initial weight loss maintenance | 3 | | 141[b] 163[a] 147[b] | |
| Trying to lose weight at study entry (rather than maintain) | 1 | | | 147[b] |
| Medical trigger (to weight loss) | 1 | | 146[bc] | |
| ***Behavioral*** | | | | |
| Physical activity | 5 | | 140[b] 141[b] 163[fΦ] 166[aϑ] 15[dε] | |
| Energy intake | 3 | | | 140[b] 141[b] 15[dε] |

**Table 4.** Association of sociodemographic, behavioral, and psychological characteristics with the magnitude of weight loss maintenance (Continued).

| Correlates | Magnitude of weight loss maintenance | | | |
|---|---|---|---|---|
| | Number of studies | No association | Significant association | |
| | | | Positive | Negative |
| Protein intake | 1 | | 166[aø] | |
| Fat intake | 3 | | | 140[b] 141[b] 163[f] |
| Carbohydrate intake | 1 | | 141[b] | |
| Sweets consumption | 1 | | | 140[b] |
| Having a healthy eating pattern⊃ | 1 | | 175[a»] | |
| Sleep quality | 1 | | 174[a»] | |
| Television viewing | 1 | | | 140[b] |
| Fast food consumption | 1 | | | 141[b] |
| ***Psychological*** | | | | |
| Weight-related teasing◘ | 1 | | | 169[c⊥] |
| Eating restraint | 2 | 169[c⊥] | 163[f] | |
| Disinhibition | 3 | | | 150[b] 163[f] 147[b] |
| Internal disinhibition | 2 | | | 156[e] 157[b] |
| External disinhibition | 2 | 156[e] 157[b] | | |
| Emotional eating | 1 | | | 169[c⊥] |
| External eating | 1 | 169[c⊥] | | |
| Dieting consistency | 1 | | 145[bc] | |
| Neuroticism | 1 | | 172[aø] | |
| Conscientiousness | 1 | | 172[aø] | |
| Internal orientation (locus of control) | 1 | | 178[a] | |

**Table 4.** Association of sociodemographic, behavioral, and psychological characteristics with the magnitude of weight loss maintenance (Continued).

| Correlates | Magnitude of weight loss maintenance | | | |
|---|---|---|---|---|
| | Number of studies | No association | Significant association | |
| | | | Positive | Negative |
| Binge eating | 1 | | | 162[a⊥] |
| Total support | 1 | | | 176[aϽ] |
| Total sabotage | 1 | 176[a!] | | |

[Φ] Leisure-time physical activity; [ϑ] Moderate-plus-vigorous physical activity; [ε] Baseline levels were not predictive of weight regain. Decreased physical activity levels or increased energy intake over time were associated with 3-year weight regain; [⊃] Healthy eating pattern = higher consumption of unprocessed cereal, fruit, vegetables, eggs, olive oil, beverages (such as coffee and tea), low-fat dairy and low-fat cheese, and lower consumption of processed cereal, sweets, spreads/sauces, high-fat cheese and junk food; [□] Retrospective weight-related teasing during childhood and adolescence; [϶] Significant for "support from family for diet", "support from family for exercise". Non-significant for "support from friends for diet", "support from friends for exercise"; [!] Significant for "sabotage from family for diet". Non-significant for "sabotage from family for exercise", "sabotage from friends for diet", "sabotage from friends for exercise".

[ø] Association observed only in women; [»] Association observed only in men.
[a] Weight loss maintenance (WLM) at baseline; [b] WLM at 1-year follow-up; [c] WLM at 2-year follow-up; [d] WLM at 3-year follow-up; [e] WLM over 5-year follow-up; [f] WLM over 10-year follow-up.
[⊥] WLM expressed as a difference in BMI

# Discussion

Losing weight and maintaining the weight loss over time remains a challenge for most people. Weight loss interventions are successful on initial weight loss, but the weight is usually partially or totally regained.[10-12] However, some individuals succeed on maintaining the weight loss over time.[(e.g.,16,179)] Studying the characteristics of these individuals as well as the strategies they use to manage their weight, is therefore critical in order to develop evidence-based solutions for weight loss maintenance.

This dissertation sought to characterize the existing weight control registries and to identify the sociodemographic, cognitive and behavioral characteristics of their participants. Additionally, it aimed to identify potential correlates of the magnitude of weight loss maintenance. To the best of my knowledge, this is the first systematic review providing a comprehensive comparison of the existing weight control registries and their participants across the world, allowing the identification of key influential characteristics. This assumes considerable relevance since it provides further insights into the phenomenon of weight loss maintenance *versus* weight regain in general, while it is also informative to guide and optimize future public health and weight management interventions and policies.

## *Main findings*

### *Who succeed in weight loss maintenance?*

This review identified five weight control registries around the world, which are based in Europe (Portugal, Germany, Finland and Greece) and in North-America. These five weight control registries gather sufficient and consistent evidence from different countries certifying that weight loss can be achieved and successfully maintained. This can provide motivation and hope to those struggling to achieve long-term weight reductions. Most participants were obese (BMI $\geq$ 30 kg/m$^2$) before their weight loss and their BMI varied between 25.0-30.1 kg/m$^2$ after the weight loss, showing that they still had excess weight at study entry. All registries have set a realistic, clinically significant minimum amount of weight loss for eligibility[13] (for example, in Portugal a 5 kg weight loss represents more than 5% weight loss for most overweight individuals;[180,181] averages of 19.8% and 31.1% in 2 of them), suggesting that participants improved their lifestyle and health.

Weight control registries have, however, some differences between them, particularly in what comes to eligibility criteria, differing on both magnitude and duration of weight loss maintenance required to entry the study. These incongruencies may be explained because of the non-consensus regarding the definition of weight loss maintenance.[85] The frequency and methods of assessments are other two key-points in which registries are different which might impair comparability between groups.

The majority of participants were middle-aged women, which is in accordance with the fact that women have a higher prevalence of obesity[182] and are more likely to be attempting to control their weight (comparing to men).[8] There is not much information about the ethnicity of the samples of weight control registries. Only the American weight control registry reports ethnicity percentages; however, the majority of participants are white (95%), and therefore are not representative of other ethnic groups or ethnic minorities. The majority of participants are highly educated, employed and married (or have a civil union).

### *What characterizes successful weight loss maintenance?*

In what comes to sociodemographic characteristics, it seems that there are not much variables explaining successful weight loss maintenance. Socioeconomic status is a sociodemographic combined measure of one's education, occupation and income.[183] This variable seems not to be associated with the success of weight loss maintenance, which is in agreement with other studies.[22,184] In contrast, a recent meta-analysis found lower socioeconomic status to be associated with excess weight (however, only in women).[185] In fact, socioeconomic differences appear to be associated with different weight control practices[186] and different weight and behavioral outcomes,[187] being the lower socioeconomic classes the less favored. Using data from the Australian Longitudinal Study on Women's Health, authors from one study[188] found that women of lower social classes gained significantly more weight over 2 years than upper social classes women. However, they have not found any significant difference in weight gain between high and low education level women.

Analyzing the literature, education[189] and more specifically health literacy[78] seem to be consistently linked with weight, with most educated individuals having lower rates of excess weight (at least in more developed countries). One possible explanation of this association could be because more educated individuals are more likely to have a clearer consciousness of the benefits and risks of lifestyle choices and have also better access to health-related information.[190] A recent meta-analysis found that the relationship

between education and overweight could be reciprocal, i.e., not only low educated individuals are more vulnerable to excess weight, but also overweight individuals are more likely to have difficulties in education attainment.[191] However, the present review and other[22] found no association between education and the process of weight loss maintenance. Different definitions of socioeconomic status using education, income and occupation interchangeably[192] and self-reported data may explain the inconsistencies between findings of the studies. These findings need to be better explored but it seems encouraging as apparently individuals can be successful at weight loss maintenance regardless their background and also puts emphasis on other factors, most of them modifiable such as behaviors.

Race/ethnicity also appears to have no association with weight loss maintenance. However, the literature tell us that weight perceptions and weight management behaviors vary by race/ethnicity,[193] the process of weight loss maintenance being likely to vary according to it as well.[194,195] Given the fact that most of the studies usually do not have sufficient representativeness of each of the different ethnicities,[196] it is difficult to understand these mechanisms and this can therefore explain the non-association found.

Age, on its turn, seems to be inversely associated with the magnitude of weight loss maintenance. However, contrary to our findings, randomized controlled trials found that older adults were more successful at losing weight and maintaining it.[197,198] Possibly explaining these findings was the fact that older individuals seem to have an overall healthier dietary pattern, better adherence to behaviors (including self-monitoring) and also seem to have more available time and less barriers. However, those findings were verified for $\geq$ 60 years old individuals and weight control registries comprise mostly middle-age individuals, possibly not reflecting the same pattern. On the other hand, a systematic review found no association between weight loss maintenance and age,[22] unveiling inconsistencies between studies.

Both body weight and lifetime maximum body weight were positively associated with the magnitude of weight loss maintenance; other studies verified larger weight losses for individuals with heavier weight.[199] The magnitude of initial weight loss was, on the other hand, somewhat controversial, as it was found to be positively (1 study) and negatively (2 studies) associated with the magnitude of weight loss maintenance. Indeed, studies are controversial regarding this topic.[194,200,201] One possible explanation could be the fact that those who achieved greater initial weight losses might be more committed to the process and thus reflect better compliance with the weight control behaviors (in both weight loss and maintenance phases).[202] On the contrary, individuals

that lost a great amount of weight might have had to make greater lifestyle changes that are hard to sustain over time, resulting in weight regain.[194]

The duration of weight loss maintenance at study entry was consistently, positively associated with the magnitude of weight loss maintenance. Another study[194] reported that weight regain was twice as high in individuals with fewer years since reaching their maximum weight, supporting this finding. This suggests that maintenance becomes easier over time, probably because the newly adopted weight control behaviors become habits (automatic), demanding less conscious effort and perhaps bringing more pleasure.[203,204,148]

According to this systematic review, medical-triggered weight loss also seems to be particularly maintained, perhaps because individuals perceive that their prior weight was the cause of the medical crisis.[205] Additionally, individuals who were trying to lose weight at study entry were more likely to regain weight than those who were trying to maintain it. This can probably be explained by the setting of unrealistic goals, which therefore can probably make individuals dropping out of the process of weight management and potentiate weight regain.[90]

Weight control registry' participants have used a variety of different (and, to some extent, individualized) behavioral strategies to achieve weight loss and maintenance. In line with the most recent guidelines,[13,21,98] the most frequently reported strategies encompassed reductions in energy intake (e.g., limiting intake of certain foods, more specifically, reducing sugary and fatty foods and fat in meals) and increases in energy expenditure (through physical activity/exercise). In fact, reducing fat consumption and reducing sweets consumption were found to be significantly associated with weight loss maintenance, as seen in other reviews.[206,207,208] Physical activity, energy intake and also fat intake were the most consistent behavioral correlates of the magnitude of weight loss maintenance, which is corroborated by the most recent systematic review on determinants of weight loss maintenance.[22]

Physical activity appears to be a popular strategy to weight management, however, weight control registries participants seem to engage in more physical activity as a strategy to lose weight rather than for maintaining it. Physical activity in general, leisure-time physical activity and moderate-plus-vigorous physical activity were positively associated with the magnitude of weight loss maintenance in this systematic review, as seen in other studies.[99,209,210] Besides this, participants reported increased the daily life physical activity (using strategies like using stairs rather than elevators, walking instead of driving/taking public transportation and parking away from destination) as strategies

to weight control. Particularly, *walk instead of driving or taking public transportation* was found to be positively associated with weight loss maintenance. This type of non-structured physical activity does not require specialized equipment and can be easily integrated into individual's daily routine.[211] It also seems to contribute to total physical activity and, therefore, can help regulate weight.[212] However, more longitudinal and randomized controlled trials in this area are needed in order to reinforce the evidence and promote conditions to people adopt these behaviors, namely through policies regarding urban planning.

Linked to physical activity is the concept of sedentary behavior. This is defined as "any waking behavior characterized by a low energy expenditure (≤1.5 METs) (e.g., sitting time)"[213] and is associated with poorer health outcomes.[214] Although some studies report sedentary behavior as a predictor of poorer successful weight loss maintenance at least in specific populations – African American women[215] and bariatric surgery patients,[216] it is not firmly established the relationship with weight status[217] due to lack of quality data (the majority of studies are based on self-reported data and cross-sectional). Television viewing (a form of sedentary behavior) was associated with weight regain in this systematic review, as seen in other study.[194] In fact, television viewing, additionally to low energy expenditure, may also promote more exposure to food advertisements which can change eating behaviors[218] and increase energy intake.[219]

Evidence suggests a relationship between poor sleep and excess weight/lower weight loss[220,221] and this can probably be explained by its effect on regulating metabolism and appetite.[222] Sleep restriction has been shown to decrease insulin sensitivity, decrease glucose tolerance, increase ghrelin levels and evening cortisol, decrease levels of leptin and increase the drive to eat.[222] Not only the duration of sleep contributes to this, but also sleep quality plays an important role on enabling these physiological mechanisms.[223] Having a higher BMI can cause trouble in sleeping such as obstructive apnea,[224] so the relationship between these two variables may even be reciprocal. Recent data suggests that poor quality of sleep (e.g., difficulties falling/staying asleep, early final awakening, non-restorative sleep) was associated with weight gain, regardless of sleep duration.[225] Other study showed that both sleep time and quality predicted greater fat loss.[226] These findings are in accordance with the ones found on this review, except that in this review this association is only verified for men. No differences between sex were found in these studies. However, evaluating the quality of sleep is usually subjective and, therefore, difficult to measure. The mechanisms linking sleep with weight are complex and under explored; future research is needed but this

finding supports the idea that sleep quality, even more than duration, can have a link to excess weight, and this can differ by sex.

Other popular strategies among weight loss maintainers were related with improving the quality of the diet by making healthier choices (e.g., increasing vegetables consumption, having regular breakfast intake). Having a healthy eating pattern appears to be positively associated with weight loss maintenance in this systematic review, as was seen in other studies.[227-229] In fact, national and international dietary guidelines[230-233] suggest a high consumption of fiber-rich foods (such as vegetables, fruit and whole-grains) and a low consumption of highly-processed foods rich in fat, sugar and/or salt, alcohol and fast food in order to have a healthy diet. In this systematic review, fast food and sweets consumption were found to be variables negatively associated with successful weight loss maintenance, supporting these recommendations. Eating breakfast regularly also appears to be positively associated with weight control, which is corroborated by other studies[234,235] probably by preventing overeating during the rest of the day (always taking into account the nutritional quality and quantity of the meal). However, some recent studies suggest otherwise, showing that consuming breakfast may increase daily energy intake and favor weight regain.[236] The fact that weight control registries' participants reported this kind of strategies suggests that the public health message for improving the quality of the diet has been endorsed, at least by these individuals.

Reducing the consumption of carbohydrates-rich foods (e.g., rice, pasta, bread) was also a somehow prevalent strategy, particularly for weight loss, although it was found to be both positively and negatively associated with weight loss maintenance in this review. In fact, dietary macronutrient composition for weight management is a controversial topic. A recent controlled feeding trial comparing low-carbohydrate and low-fat diets (with equal amount of protein) found that low-carbohydrate ones may be more effective for weight management since they seem to increase energy expenditure.[237] On the other hand, a meta-analysis of controlled feeding studies found that there is no much difference between low-carbohydrate diets and low-fat diets (both isocaloric diets with equal amount of protein), with low-fat diets showing small (physiologically meaningless) results in terms of greater fat loss and increase on energy expenditure.[238] Theoretically a reduction in fat intake would cause a greater reduction on energy intake since 1 gram of fat contains 9 kcal and 1 gram of carbohydrates contains only 4 kcal.[239] However, it is not as simple as it seems. A randomized controlled trial found no differences between long-term weight loss between low-fat and low-carbohydrate diets[240] as well as findings from meta-analysis of randomized controlled

trials which failed to prove the efficacy on weight management of specific dietary interventions over others.[239,241] Results of adherence and attrition to low-fat and low-carbohydrate diets point out low-fat as the ones usually having greater attrition rates, so it can be a key aspect to take into account.[242,243]

A clinical trial investigating the effect of diets with high versus low protein content found that a diet combining low-fat and high protein resulted in better maintenance of weight loss rather than a low-fat and high-carbohydrate dietary approach,[244] probably proposing a role of protein on weight management. In fact, increasing the consumption of protein-rich foods and protein intake were found to be positively associated with weight control in this review and this can probably be explained by physiological mechanisms of enhancing postprandial satiety signaling, regulating appetite[245,246] and changing body composition in favor of fat-free body mass.[247] In fact, higher levels of protein seem to be protective against weight regain.[207,248] However, a recent systematic review failed to show conclusive evidence supporting this hypothesis.[22] In fact, other studies[(e.g.,107,228)] and also guidelines[(e.g.,13)] suggest that emphasizing diet adherence and behavioral strategies might be better than focusing on any specific macronutrient composition of the diet, playing the personal choice a major role on defining which strategy to choose.

Reducing portion sizes, as a mean of cutting calories, was another strategy highly reported and shown to be positively related with the magnitude of weight loss maintenance, which is also supported by prior research.[22] Increasing meal frequency was also reported as a strategy to maintain weight loss in this review. Thought to control appetite, improve glucose homeostasis and increase the thermic effect of food, it has been encouraged the consumption of small and frequent meals over the day as a way of achieving better body composition (resulting this relationship from mainly observational studies).[249,250] However, studies are inconclusive.[131,251,252] Given the fact that adherence accounts greatly to the success of a nutritional intervention, this aspect should be of individual choice while there is no consistent evidence.[251]

In order to eat healthy, there are some strategies that may facilitate that. One of these, which was largely reported in this review as a strategy to both weight loss and maintenance, is planning to have healthy foods available at home, as seen in other studies.[253,254] Planning in advance prevents individuals of being “caught” in risky situations and therefore have to make unhealthy choices.[125] Setting specific goals (regarding, for example, weight loss, eating and physical activity) was a self-regulatory strategy found to be positively associated with the magnitude of weight loss maintenance probably by its effect on facilitating the initiation of behavior change and stickiness to that change[123,255] being one of the strategies encouraged by guidelines to manage weight.[98]

Other self-regulation skill found to be positively associated with the magnitude of weight loss maintenance was self-monitoring (more specifically, self-weighing), as was already expected.[118,119,256] Recording dietary intake and/or physical activity is also a self-monitoring technic that was positively associated with weight loss maintenance as well, in accordance with other studies.[257,258] However, this appears to be only significant for women in this systematic review.

Importantly, few participants reported using weight management aids (meal substitutes, weight loss supplements) and, in fact, taking weight loss supplements was shown to be negatively associated with weight control in one of the included studies. Other studies found limited or no evidence on the effectiveness of meal substitutes or weight loss supplements on weight management, and even reported some potential health risks.[9,259,260]

Methods for weight loss such as surgery, and the use of medications were also two strategies reported by participants (even so two of the least reported ones); these are proven to be effective ways on attaining successful weight loss maintenance.[261,262] Nonetheless, a comprehensive lifestyle intervention addressing changes in lifestyle is more recommended than using this type of strategies (however the characteristics of the individuals such as the BMI and medical history must be considered).[13]

It is noteworthy that the most frequent strategies for weight loss were also highly used for achieving weight loss maintenance. This finding is aligned with other systematic review,[206] suggesting that weight loss and maintenance are part of a continuous behavior change process rather than a two-phase process. However, other authors suggest that different behaviors should be considered in the phases of active weight loss and weight maintenance[263] (for example, the weight loss phase may require a greater reduction in energy intake whereas weight loss maintenance may require practices that are possible to keep on a life-long basis). Furthermore, the hypothesis that these successful maintainers still wished to lose additional weight and, therefore, were still using these strategies, cannot be entirely rejected.

These results suggest, firstly, that there is no “one size fits all” behavioral approach for weight loss and maintenance. For example, different clusters of participants were identified in the US registry based on distinct experiences, strategies, and attitudes with respect to weight loss and weight loss maintenance.[137] Secondly, in line with previous guidelines,[(e.g.,100)] they suggest there is likely a dose-response, with greater weight losses being achieved with greater doses of physical activity and lower energy and fat intake (despite the cross-sectional data analysis). Still, the variability in eating

and physical activity behaviors observed in these successful weight loss maintainers (results not shown) stresses the fact that achieving energy balance is highly individually determined, related to the required amount of physical activity depending on the magnitude of energy restriction.

Eating behavior affects energy intake and, consequently, can have an effect on determining weight loss maintenance. In fact, in this review, the psychological variable more consistently negatively associated with weight loss maintenance was disinhibition, as seen in other studies.[201,256,264] This might be explained as this trait is probably related with overeating and binge eating episodes[111] (i.e., periods of overeating characterized by the consumption of a large amount of food and a sense of loss of control over eating),[265] which was also found to be negatively correlated with weight loss maintenance in this review. However, other studies found disinhibition to have no association with weight loss maintenance.[90] This incongruence might be explained by regarding disinhibition as a unique concept. In fact, studies are more congruent when analyzing internal (eating in response to cognitive/emotional cues) and external (eating in response to environmental cues) disinhibition in separate, being lower levels of internal disinhibition a predictor of weight loss maintenance whereas external disinhibition is not[22,109] as was found in this review.

Another concept of eating behavior analyzed in this review was dietary restraint. In accordance with other studies,[266] higher levels of dietary restraint were associated with successful weight loss maintenance in this review. In fact, if well implemented, a high level of restrained eating can effectively result in calorie restriction.[264] On the other hand, this systematic review also showed no association between these two variables. In accordance with this finding, other studies found no association between dietary restraint with weight gain[267] and even a positive association between dietary restraint and emotion-induced eating.[268] This inconsistency can probably be explained by the relatively recent distinction between two dimensions within the cognitive eating restraint (flexible and rigid),[269] as in the past it was regarded as a unique concept.[270] This distinction provides further insights of eating behavior on weight management. In fact, some studies found flexible cognitive eating restraint to be associated with medium-/long-term weight control whereas rigid eating restraint had no association or even has a negative association with weight control.[24,264,271] Whilst the flexible restrainer has less internal pressure to diet, the rigid restrainer has a more *all-or-nothing* approach to dieting and when fails on doing it, it could probably create a negative emotional response and even create moments of disinhibition.[264] This could be explained by the fact that rigidity can increase the tension of the weight management process,[272] and flexibility, in turn,

can promote easier adaptation to the situations and predict health and psychological well-being.[273] As the studies of this systematic review did not distinguished between the two concepts it is difficult to take conclusions on this variable.

Dieting consistency (across both week and year) was another eating behavior variable found to be positively associated with weight loss maintenance (rather than having more strictness on weekdays/non-holiday periods). In accordance with this finding, one very recent study from the Portuguese Weight Control Registry (not included in the present review) found that being more strict on weekends (versus weekdays) predicted weight regain at 1 year follow-up.[274] Other study found that lower intake variability predicted greater weight loss at 12 months (by probably reducing the overall energy intake).[275] Weekends and holidays are moments when there is more probability of having social occasions and exposure to energy-dense foods. Having rigid eating patterns can help on reducing the caloric intake but can also have a countereffect as individuals may perceive deprivation,[276] which can lead to cycles of overeating and restriction.[274] On the other side, being flexible only for some periods may create more opportunities to lose control due to exposure to high-risk situations,[179] proving that consistency may be the key to success in weight control behaviors as seen in other studies.[277]

The western “body ideal” spread on media is the slimmer one and this appears to have great influence on how individuals see their selves and the others.[278] Furthermore, individuals with excess weight are often regarded as lazy, lacking in self-discipline and motivation and less competent[279] and are often victims of stigmatization and discrimination.[280] Derived from weight stigma and discrimination, can occur weight bias internalization, i.e., individuals with excess weight come to agree, accept and endorse those ideas and stereotypes to themselves.[281] The internalization of weight bias is believed to be associated with increased vulnerability to the negative psychological consequences of weight stigma, resulting in lower self-esteem and body image concern, higher perceived stress, depression and anxiety[281] and less successful weight loss maintenance.[282] As the experiences of discrimination and stigma can induce stress and negative emotions to the individual, emotional eating can be used as a coping strategy to deal with it,[283] increasing the amount of energy eaten[110] and even possibly resulting in episodes of binge eating.[284] In fact this is what this systematic review found: retrospective weight-related teasing during childhood and adolescence (considered a type of discrimination[285]) was associated with less successful weight loss maintenance and this relationship seems to be mediated by emotional eating.[169]

Higher levels of neuroticism (characterized by low emotional stability, sensitivity to negative emotions, anxiety proneness) and conscientiousness (characterized by self-control, adherence to social norms, orderliness)[286] were found to be positively associated with successful weight loss maintenance (although only in women). Some traits of personality appear indeed to be linked with weight control. In fact, a positive association between neuroticism and emotional eating has been found,[287] possibly derived from a more emotionally vulnerable state (characteristic of this trait) and subsequent search for comfort in food. Conscientiousness (characterized by self-control), on the other hand, was found to facilitate the adoption and maintenance of healthier behaviors over time and greater weight loss.[288] Being high in neuroticism and low in conscientiousness is also more associated with developing depression[289] and binge eating.[290] These findings might suggest that being high in conscientiousness and low in neuroticism will likely be associated with better weight management.[291] However, some studies[(e.g.286,292)] (including this review) found different results than what was expected. The cultural and sex specificities underlying the relationship between weight and personality[286,293] may explain these contradicting findings.

One finding that seems to be odd at first is the negative association between total perceived support and weight loss maintenance. Yet, other studies found the same association.[294,295] In fact, some participants reported, as a strategy to weight control, counting on the support from family and friends. Support may also be recognized by the individual as a form of stigmatization and eventually, as previously mentioned, increasing stress levels of individuals which may impair weight management.[294] Contrary to these findings, other studies found a positive association between social support and weight loss maintenance[296] or even no association between them.[90] In fact, there are different types of support and those which promote autonomy seem to predict better results than those which can act as controlling, possibly explaining the controversial findings between studies.[297,298]

Participants of weight control registries reported to receive professional support more often from healthcare professionals or weight control programs rather than self-help weight control groups. Evidence shows that this type of support is more effective than self-help programs: a multicenter randomized trial showed that structured commercial programs (consisting of a food and physical activity plan and a behavior modification plan focused on cognitive restructuring and weekly group meetings) provided greater weight losses over a 2 year period than self-help groups (20-minute consultations with a dietitian on weeks 0 and 12 and given access to information for a

safe weight-loss, e.g., available printed materials with dietary and physical activity principles).[299]

In what comes to sabotage (i.e., negative social interactions that attempt to hinder goal attainment, whether intentionally or not[296]), no association was found with weight loss maintenance. However, in other studies these two variables seem to be negatively associated, with higher levels of sabotage being associated with weight gain.[296] These saboteurs are frequently family and friends and sabotage can be demonstrated, for instance, as saying statements regarding individuals appearance, questioning their choices regarding lifestyle habits, and attempting to discourage their efforts or encouraging them to stop dieting at a certain point.[300]

Finally, a variable found to be associated with weight loss maintenance was locus of control. Locus of control refers to the belief a person has in the control of his/her life.[301] This construct can be divided into two different concepts: the internal orientation and external orientation. “Internals” are characterized by doing more efforts to control their environment and to take responsibility for their actions.[302] Contrary to this, “externals” tend to attribute external factors outside their control to goal attainment.[302] A more internal orientation is possibly linked to higher levels of self-efficacy[303] and higher self-esteem[304] whereas external orientation was previously associated with depression and anxiety.[305] Thus, from this point of view, being more “internal” and less “external” could be beneficial to the weight management process, although this may be much more complex than it seems. In this systematic review, internal orientation is positively associated with weight loss maintenance. Some studies support this relationship,[306] although others do not.[307] Both of these orientations appear to bring benefits; thus it has been suggested that the ideal would be having the best of both worlds i.e., to be sufficiently internal to believe they can bring their weight under control but also sufficiently external to listen to the advice of healthcare professionals, for example.[306] To counteract the weaknesses of both orientations, weight management interventions should be tailored properly. Whilst “internals” tend to benefit more from self-directed and autonomous interventions, “externals” might benefit more from individualized face-to-face counselling with a particular emphasis on self-efficacy.[178,306]

### *Strengths and limitations*

The main strength of this dissertation is the comprehensive characterization of the existing weight control registries and, therefore, of (nationally recruited samples of)

successful weight loss maintainers from different parts of the world. Although sample sizes are considerably large, their nature (volunteers) precludes the generalization of these results to the population under scrutiny – nationwide successful weight loss maintainers. Recruiting individuals through web-based platforms allow the recruitment of more heterogenous samples (e.g., individuals from different counties/regions). However, it also limits participation to individuals with certain levels of digital literacy, potentially narrowing the sample characteristics. Additionally, this type of studies is subject to selection bias towards more motivated individuals.

Although important characteristics, strategies and correlates were identified (through valid and reliable instruments), discrepancies across the weight control registries (particularly regarding enrollment criteria and assessments) represent an important limitation when establishing comparisons between them. Research in different countries and cultural settings, with standardized methodologies and tools, would add to the generalizability by increasing accuracy and comparability.

The self-reported nature of most data (including for registry eligibility) can lead to response bias associated with recall difficulties, social desirability and under- or overestimations).[308,309] Nevertheless, since there is no intervention with the participants and most registries do not offer financial incentives or other major benefits from entering, we assume there is little reason for participants to misreport information, at least their weight history. Additionally, some studies show that self-reported data, such as weight and height, strongly correlate with objectively measured data.[310]

The taxonomy used to classify the strategies used by weight control registries' participants - OxFAB taxonomy - was chosen because it is a valid and reliable tool[113] which allows the report of behavioral and cognitive strategies for weight management. The authors recognize that this taxonomy might not include all the strategies for weight control;[113] in fact, in this systematic review, one domain - dietary choices - was added because some strategies reported did not fit in any other domain.

Regarding study methodology, some included studies scored "weak" as their global score, but they still could contribute to this dissertation and, therefore, were included. Despite the efforts, there are still some articles that could not be accessed (n=36) and therefore some information may have been lost.

Finally, the observational nature of the registries and the cross-sectional design of most studies, even though with a retrospective or prospective nature, prevent from drawing firm conclusions about the causal direction of the associations between correlates and the magnitude of weight loss maintenance. The possibility of reverse

causality cannot be excluded and therefore results should only be interpreted as suggestive and supportive.

### *Implications and recommendations*

Considering the significant burden associated with excess weight, it is imperative to take action for counteracting trends. Strategies specific for weight loss are largely studied; in comparison, strategies for weight loss maintenance are limited and lack solid evidence.[9,106]

To expand the knowledge in this area, it is recommended long (12-24 months) randomized trials comparing two or more approaches to weight management.[20] However, this type of studies are costly, so the other reliable approach is to explore key correlates of successful long-term weight control (physiological, behavioral and psychological) and related behaviors in order to improve the understanding of weight loss maintenance-related processes.[20,112] Profiling methodologies (e.g., cluster analysis) could be useful, if the goal is to design tailored and, therefore, effective weight management interventions. Weight control registries can definitely contribute to that.

Acting like surveillance and monitoring methods, as suggested by the World Health Organization as means to counteract obesity,[(e.g.,61,80,81,311)] weight control registries allow the identification of individuals who succeed in losing weight and keep that weight off, but also enables the screening and monitoring of the characteristics and cognitive and behavioral strategies used by these individuals to achieve success, thus, possibly helping other individuals seeking weight loss maintenance and informing public health researchers and practitioners.

In order to capture a better picture of the real-world weight loss maintainers, more countries with different sociocultural, physical and policy milieus should consider implementing weight control registries. Besides high-income countries, overweight and obesity prevalence rates are also increasing in low- and middle-income countries.[312,313] Also, given the cultural specificities (for example, given the physiological differences between races/ethnicities, some studies suggest different BMI cutoffs according to ethnicity[314]) of each country, it is important to widen the implementation of weight control registries worldwide. This will help bridge the monitoring of successful weight loss maintenance in the adult population, thus informing and advancing future clinical and research practice.

However, based on the findings of the current review, there are some recommendations for future countries which intend to implement a similar weight control registry. A more sophisticated sampling technique, more frequent assessments and including a group of both weight loss maintainers and regainers (following the same pattern as the Greek weight control registry) may provide opportunities to explore other specificities of successful weight loss maintainers. Whenever possible, the measurements should be objective rather than self-reported and other anthropometric measurements should be conducted besides weight/BMI and waist-to-hip circumference. Given the individual variability that can affect weight management,[20] it is critical to include more heterogeneous samples (e.g., in sex, race/ethnicity, age, etc.). In fact, in this systematic review, some variables were only associated with a certain sex, possibly reflecting differences between men and women on the weight management process.

As weight control registries have differences between them (e.g., instruments to assess participants, inclusion criteria), it is important to standardize protocols which would facilitate the exchange of information and would allow a more precise comparison between them. The standardization of surveillance methods is, indeed, a good practice recommended by the WHO.[315] Therefore, the establishment of standard guidelines would be a critical tool for the creation of new weight control registries across the world, facilitating consistency in data collection and interdisciplinary collaboration, and more accurately informing public health and obesity prevention and treatment research and practice.

# Conclusions

This dissertation provided further insights into weight loss maintenance-related processes, by identifying 5 weight control registries across the world and key sociodemographic, cognitive and behavioral characteristics of successful weight loss maintainers, as well as correlates of the magnitude of weight loss maintenance, providing valuable insights into the public's response to the (excess) weight problem and suggesting evidence-based clues for future public health and obesity prevention and treatment initiatives.

The majority of the self-reported weight management strategies were in accordance with the current guidelines to weight management, encompassing reductions in energy intake and increases in energy expenditure, and also the use of self-regulatory skills, such as self-monitoring. A higher percentage of weight control registries' participants reported choosing more often health-promoting strategies rather than potentially harmful ones, which is encouraging.

According to this study, the majority of sociodemographic factors seem not to be correlated with successful weight loss maintenance. On the contrast, several behavioral and psychological correlates seem to influence it. The correlates which better explain weight loss maintenance were physical activity, protein intake, breakfast consumption, reducing portion sizes, self-weighing, dieting consistency, having internal orientation (locus of control) and goal-setting. On the other hand, the factors inversely associated with weight loss maintenance were energy, fat and sugar intake, television viewing, weight loss supplements consumption, weight-related teasing, disinhibited eating (more specifically eating in response to emotional cues), binge eating and total perceived support.

The current study adds to the literature by summarizing the information regarding the weight control registries and the characteristics of successful weight loss maintainers, providing important clues for those who seek weight loss maintenance, as well as for clinical research and practice. The standardization of protocols between weight control registries would facilitate the exchange of information and allow a more precise comparison between them, as well as the implementation of new ones by other countries. Despite the limitations, weight control registries provide valuable information about the habits, strategies and characteristics of individuals successful at weight loss maintenance through valid and reliable batteries of instruments and their results should be considered when studying this topic.

The process of weight loss maintenance is much more complex than it seems. We cannot dissociate the individuals from all the spheres that make part of them: physiological, psychological, behavioral, environmental, etc. This dissertation helped on detailing what works for these successful weight loss maintainers and therefore, provided evidence-based information that could be considered in future weight management interventions with the ultimate goal of promoting public health.

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# Appendices

## *Appendix A. Protocol registration*

**PROSPERO**
**International prospective register of systematic reviews**

NHS National Institute for Health Research

Behavioural characteristics of successful weight loss maintainers: a systematic review of weight control registries

*Catarina Paixão, Carlos Dias, Rui Jorge, Eliana V. Carraça, Pedro J. Teixeira, Inês Santos*

### Citation

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### Review question

How many weight control registries exist across the world?

What are the characteristics (e.g., country, enrolment criteria, procedures) of the existing weight control registries?

What are the sociodemographic and behavioural characteristics of successful weight loss maintainers?

### Searches

A comprehensive search of peer-reviewed articles was conducted on three electronic databases: PubMed, Web of Science and Scopus (all articles published until November 2018). Additionally, manual cross-referencing of retrieved articles and hand-searches of key scientific journals was performed.

### Types of study to be included

Cross-sectional and longitudinal studies

### Condition or domain being studied

Long-term weight loss maintenance has proven to be challenging for many individuals. Therefore, knowing how those people already successful at long-term weight management are able to lose weight and, especially, maintain it, is critical to inform public health/obesity interventions and make them more effective. In this context, several countries established weight control registries, with the aim of identifying the main psychological and behavioural characteristics of successful weight loss maintainers in their specific contexts.

### Participants/population

Studies were selected for this review if they included samples from weight control registries.

### Intervention(s), exposure(s)

Not applicable

### Comparator(s)/control

Not applicable

### Context

### Main outcome(s)

Characteristics (e.g., country, enrolment criteria, procedures) of the existing weight control registries

Sociodemographic and behavioural characteristics of successful weight loss maintainers

### Timing and effect measures

Not applicable

### Additional outcome(s)

None

## Timing and effect measures

Not applicable

## Data extraction (selection and coding)

This systematic review will be reported in accordance with the MOOSE (Meta-analysis of Observational Studies in Epidemiology) guidelines.
Potentially eligible studies were independently identified by two authors (CP, IS), based on title, abstract and references. Duplicate entries were removed. Relevant articles were then retrieved for a full-text review. The same two researchers independently reviewed the full-text of potential studies (k=156) and discrepancies were resolved by consensus. Sixty studies met eligible criteria for entering the review. Four researchers (CP, RJ, EVC, IS) will independently code and extract the relevant information to be included in systematic review summary tables, namely information about the weight control registries (country of origin, year of implementation, sample size, recruitment procedure, period of recruitment, inclusion and exclusion criteria, and methodologies used) and about the participants (sociodemographic data, weight history, weight loss and weight maintenance strategies).

## Risk of bias (quality) assessment

The methodological quality of included studies will be assessed using an adapted version of the Quality Assessment Tool For Quantitative Studies developed by the Effective Public Health Practice Project. The adapted version of the Quality Assessment Tool For Quantitative Studies addresses 1) Study design, 2) Representativeness (Selection bias), 3) Representativeness (withdrawals and drop-outs), 4) Confounders, 5) Data collection, 6) Data analysis and 7) Reporting. A global rating will be determined based on the scores of each item. Four researchers (CP, RJ, EVC, IS) will independently rate each of the seven domains and overall quality. Disagreements will be resolved by consensus.

## Strategy for data synthesis

Information about the weight control registries (e.g., country of origin, year of implementation, sample size, recruitment procedure, period of recruitment, inclusion and exclusion criteria, and methodologies used) and relevant information about the participants (e.g., sociodemographic data, weight history, weight loss and weight maintenance strategies) will be synthesised and presented in tabular form.

## Analysis of subgroups or subsets

None planned

## Contact details for further information

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## Organisational affiliation of the review

Faculty of Human Kinetics, University of Lisbon

## Review team members and their organisational affiliations

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## Type and method of review

**PROSPERO**
**International prospective register of systematic reviews**

NHS National Institute for Health Research

Systematic review

## Anticipated or actual start date
01 November 2018

## Anticipated completion date
30 June 2019

## Funding sources/sponsors
This study was funded by Grants from the Portuguese Science and Technology Foundation (PTDC/DES/72317/ 2008-2011).

## Conflicts of interest

## Language
English

## Country
Portugal

## Stage of review
Review Ongoing

## Subject index terms status
Subject indexing assigned by CRD

## Subject index terms
Body Weight; Humans; Registries; Weight Loss

## Date of registration in PROSPERO
03 June 2019

## Date of publication of this version
03 June 2019

## Details of any existing review of the same topic by the same authors

## Stage of review at time of this submission

| Stage | Started | Completed |
|---|---|---|
| Preliminary searches | Yes | Yes |
| Piloting of the study selection process | Yes | Yes |
| Formal screening of search results against eligibility criteria | Yes | No |
| Data extraction | No | No |
| Risk of bias (quality) assessment | No | No |
| Data analysis | No | No |

## Versions
03 June 2019

## *Appendix B. Methodological quality assessment of articles (tool)*

**EPHPP QUALITY ASSESSMENT TOOL (adapted)**

**STUDY #** **RATER _____**

**STUDY DESIGN**

(**Q1**) The study design is:

1. Experimental
    i. Individual-randomised
    ii. Group-randomised
    iii. Non-randomised
2. Observational
    i. Cross-sectional
    ii. Longitudinal (also natural experiment or pre-post tests)
    iii. Case-control
3. Any other method (i.e. pre-post test without control group) or did not state method

(**Q2**) Was this an intervention study?

**Yes** – proceed
**No** – go to question 7

(**Q3**) Is the intervention of interest clearly described?

1. Yes
2. No
3. Not applicable (if using an existing database and referring to design article*)

(**Q4**) Were (groups of) subjects randomized into intervention groups?

1. Yes
2. No
3. Can't tell
4. Not applicable (if using an existing database and referring to design article*)

(**Q5**) Was the intervention assignment concealed from participants and care givers until recruitment was completed?

1. Yes
2. No
3. Can't tell
4. Not applicable (if using an existing database and referring to design article*)

(**Q6**) Was (were) the intervention or exposure status of participants concealed from the outcome assessors?

1. Yes
2. No
3. Can't tell
4. Not applicable (if using an existing database and referring to design article*)

(**Q7**) Were power/sample size calculations conducted?

1. Yes, details of calculation provided
2. Yes, no details provided
3. Not reported or post hoc computation
4. Not applicable (if using an existing database and referring to design article*)

**Rating study design:** **Strong:** Q1 is 1
**Moderate:** Q1 is 2
**Weak:** Q1 is 3

**Rating blinding:** **Strong:** Q5 and Q6 are 1
**Moderate:** Q5 or Q6 is 1**; or** Q5 or Q6 are 3
**Weak:** Q5 and Q6 are 2; **or** Q5 and Q6 are 3

**No rating:** Q5 and Q6 are 4

**(No rate is given when study is not an intervention study)**

** If the study is using data from a large existing database such as HSE, NHANES, BRFSS, etc., often the authors refer to the design paper of the original study and no information in the present article is being described about power calculations, validity of tools, intervention description, etc.*

**REPRESENTATIVENESS (selection bias)**

(**Q8**) Is the spectrum of individuals selected to participate likely to be representative of the wider population who experience the intervention/exposure/situation?

1. Very likely
2. Somewhat likely
3. Not likely (selected group of users e.g., volunteers)
4. Can´t tell*
5. Not applicable*

(**Q9**) What percentage of the selected participants agreed to participate?

1. ……..%
2. Can't tell
3. Not applicable

(**Q10**) Were inclusion/exclusion criteria specified and number of exclusions reported?

1. Criteria and number of exclusions reported
2. Criteria or number of exclusions not reported
3. Criteria and number not reported
4. Not applicable (if using an existing database and authors refer to design article)

**Rating:** **Strong:** Q8 is 1
**Moderate:** Q8 is 2
**Weak:** Q8 is 3 or 4
**No rating:** Q8 is 5

***** *Rate the representativeness of each study uniquely, according to each study specific context (community, specific group of the population, particular place, etc.). If a paper is using a large national dataset and refers to a design paper in their methods section, we answer Q8 with 5 (not applicable). However, if the authors used an existing database and do not refer to a design article, the rating should be 4 (can't tell). As a result, if you have rated Q8 with 5 (not applicable), than it is not possible to give a rating for representativeness.*

**REPRESENTATIVENESS (withdrawals and drop-outs)**

(**Q11**) Were withdrawals and drop-outs reported in terms of numbers and reasons per group?

1. Numbers and reasons provided
2. Numbers but no reasons provided
3. Can't tell (if longitudinal data)
4. Not applicable (if cross-sectional data or if using an existing database and authors refer to design article)

*If Q11 is 1 or 2, proceed to Q12. Otherwise, proceed to Q13.*

(**Q12**) What was the loss to follow-up (report the percentage completing the study and if it differs by groups, record the lowest)?

1. ……..%
2. Not provided
3. Not applicable

**Rating:** **Strong:** Q11 is 1
**Moderate:** Q11 is 2
**Weak:** Q11 is 3
**No rating:** Q11 is 4

**CONFOUNDERS**

(**Q13#**) What confounders were the analyses adjusted for?

……...
……...

(**Q13**) Were analyses appropriately adjusted for confounders?

1. For most confounders
2. For some confounders
3. No or can't tell

*The following are examples of confounders: race, sex, marital status/family, age, SES (income or class), education, health status, pre-intervention score on outcome measure. Rate the confounding as good if the authors took into account several factors (independent of whether they treated them as confounders, covariables, moderators or mediators). Consider as minimum for 'most confounders' controlling for age, gender, SES.*

*Considering the study design, were appropriate methods for controlling confounding variables and limiting potential biases used? Confounding can be addressed by appropriate use of randomization, restriction, matching, stratification, or multivariable methods. Sometimes use of a single method may be inadequate. Some biases can be limited by institution of data collection or study procedures that support validity of the study (e.g. training and/or blinding of interviewers or observers, interviewers and observers are different from interventions' implementers etc). Example: if between-group differences persist after randomization or matching, statistical control should also have been used.*

**Rating:** **Strong:** Q13 is 1
**Moderate:** Q13 is 2
**Weak:** Q13 is 3

## DATA COLLECTION

(**Q14**) Were validity and reliability of the data collection tools discussed?

1. Both validity and reliability were discussed
2. Validity or reliability were discussed
3. None of them were discussed
4. A larger dataset was used and authors provided adequate information to find information on validity and reliability

**Rating:** **Strong:** Q14 is 1
**Moderate:** Q14 is 2
**Weak:** Q14 is 3
**No rating:** Q14 is 4

## DATA ANALYSIS

(**Q15**) Were appropriate statistical analyses conducted (including correction for multiple tests where applicable*)?

1. a. Statistical methods were described, appropriate and comprehensive, and used a sophisticated approach
   b. Statistical methods were described, appropriate and comprehensive, and used a simple approach
2. Statistical methods were described and less appropriate
3. No description of statistical methods or inappropriate methods

**Rating:** **Strong:** Q15 is 1
**Moderate:** Q15 is 2
**Weak:** Q15 is 3

** Consider statistical analyses to be appropriate if they account for confounding factors (so correlation analysis only is not enough). Do not punish papers for not correcting for multiple tests, if the rest of the analyses are appropriate.*

## REPORTING

(**Q16**) Are the hypotheses/aims/objectives of the study clearly described?

1. Yes
2. No

(**Q17**) Are the main outcomes to be measured clearly described?

1. Yes
2. No

(**Q18**) Are the main findings clearly described?

1. Yes
2. No

(**Q19**) Have actual probability values been reported (i.e., p = .345 instead of p > .050; same goes for t-values, 95% CIs, etc.)?

1. Yes
2. No

**Rating:** **Strong:** Q16 and Q19 are 1
**Moderate:** Q16 or Q19 are 1
**Weak:** Q16 and Q19 are 2

Studies can have between six and eight component ratings. The overall rating for each study is determined by assessing the component ratings. **Strong** will be attributed to those with no WEAK ratings and at least four STRONG ratings; **Moderate** will be given to those with one WEAK rating or fewer than four STRONG ratings; **Weak** will be attributed to those with two or more WEAK ratings. (If only six ratings have been given, Strong will be attributed to those with no WEAK ratings and at least three STRONG ratings.) The final decision of both reviewers will be: strong, moderate, or weak.

## *Appendix C. Posters associated with the dissertation*

Abstract of the poster presented at the 18th Annual Meeting of the International Society of Behavioral Nutrition and Physical Activity (ISBNPA), Prague, Czech Republic, June 2019.

ISBNPA Prague CZECH REPUBLIC 4-7 June 2019

ABSTRACT BOOK

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P3, P3.180

### Long-term weight loss maintenance: a systematic review of weight control registries

**Santos I**, C Paixão, CM Dias, R Jorge, PJ Teixeira

[1]*Centro Interdisciplinar para o Estudo da Performance Humana, Faculdade de Motricidade Humana da Universidade de Lisboa, Lisboa, Portugal*

Assessment and methodologies in behavioral nutrition and physical activity, Congress Hall Foyer Level 2, June 7, 2019, 10:50 AM - 12:05 PM

*Assessment and Methodologies in Behavioral Nutrition and Physical Activity (SIG)*

Purpose: Several countries established weight control registries, with the aim of identifying the main psychological and behavioral characteristics of successful weight loss maintainers in their contexts. The purpose of this study is to identify and systematically describe the existing weight control registries, including the sociodemographic, psychological and behavioral characteristics of their participants.
Methods: A comprehensive search of peer-reviewed articles was conducted in three electronic databases: PubMed, Web Of Science and SCOPUS (all articles published until November 2018). Searches included various combinations of the following terms: weight loss maintenance, weight control registry, national weight control registry, Portuguese, Greek, Finnish, German. Studies were selected for this review if the sample included participants of weight control registries.
Results/findings: The search yielded 187 potentially relevant studies after title and abstract screening. After full-text screening, 86 articles met the eligible criteria and were included. The MOOSE (Meta-analysis of Observational Studies in Epidemiology) guidelines were used to extract relevant information. Data extraction included information about the weight control registries (e.g., country of origin, year of implementation, sample size, recruitment procedure, period of recruitment, inclusion and exclusion criteria, and methodologies used) and relevant information about the participants (e.g., sociodemographic data, weight history, weight loss and weight maintenance strategies). The methodological quality of the studies was assessed using the EPHPP (Effective Public Health Practice Project) Quality Assessment Tool for Quantitative Studies.
Conclusions: Long-term weight loss maintenance has proven to be challenging for many individuals. Given that social, environmental, and cultural influences are thought to contribute to excess weight, systematically summarizing the characteristics of individuals already successful at long-term weight management from different populations may provide further insights into weight loss and maintenance-related processes, potentiating public health and obesity prevention and treatment initiatives in specific contexts.

Abstract of the poster presented at the XVI Congress of Food and Nutrition, Lisbon, Portugal, May 2017.


[Moderador] Vitor Hugo Teixeira
Faculdade de Ciências da Nutrição e Alimentação da Universidade do Porto

**PO49. Estratégias associadas à manutenção do peso perdido e ao reganho do peso em adultos portugueses: resultados do Registo Nacional de Controlo do Peso**

Catarina Luís[1], Inês Santos[1], Rui Jorge[1], Pedro Teixeira[1]
[1] Centro Interdisciplinar para o Estudo da Performance Humana, Faculdade de Motricidade Humana da Universidade de Lisboa

**Introdução:** A manutenção do peso é essencial para sustentar os benefícios para a saúde resultantes da perda de peso. Neste sentido, é importante compreender as alterações do estilo de vida que levam as pessoas a conseguir manter o peso perdido a longo prazo.

**Objetivos:** Explorar as estratégias cognitivas e comportamentais associadas à gestão do peso numa amostra de participantes do Registo Nacional de Controlo do Peso que manteve o peso perdido *versus* recuperou o peso perdido.

**Métodos:** Um total de 105 participantes (61,9% mulheres; idade: 40,3±10,7 anos), que tinham perdido em média 17,3±10,4kg e mantiveram esta perda de peso durante ~31 meses, foram avaliados 1 ano após entrada no Registo Nacional de Controlo do Peso. A avaliação contemplou o preenchimento de um questionário principal (com informação sociodemográfica, detalhes sobre a história do peso e as estratégias de manutenção do peso) e de uma bateria de questionários psicométricos, e ainda avaliação da ingestão alimentar, atividade física e antropometria (peso, altura e perímetro de cintura).

**Resultados:** Cerca de 69,5% (n=73) dos participantes mantiveram o peso perdido (considerando uma variação de 3%), ao passo que 30,5% (n=32) recuperaram parcial ou totalmente o peso perdido, existindo diferenças significativas no que respeita ao Índice de Massa Corporal (25,8 kg/m$^2$ vs. 28,4 kg/m$^2$, respectivamente; p=0,004). Os participantes que mantiveram o peso perdido reportaram maior frequência de refeições ao longo do dia (p=0,028), menor número de refeições fora de casa (p=0,034) e maior ingestão de gordura total (p=0,037), monoinsaturada (p=0,033) e polinsaturada (p=0,047). Não se encontraram diferenças estatisticamente significativas entre os dois grupos relativamente à prática de atividade física.

**Conclusões:** Os resultados deste estudo estão alinhados com a evidência científica atual, reforçando o papel de estratégias-chave – uma alimentação fracionada, privilegiar o consumo de refeições preparadas em casa e o consumo de gordura insaturada – para a manutenção do peso perdido a longo prazo.